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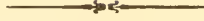
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## Studies on the Hexactinellida.

### CONTRIBUTION III.

(*Placosoma*, a New Euplectellid; *Leucopsacidae* and  
*Caulophacidae*).

By

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*With 8 plates.*

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In this contribution I propose first to describe a new stalked Euplectellid of an interesting structure, which I call *Placosoma paradietyum*. This form became known to me after I had provisionally considered my studies of the Euplectellidæ at end. It may however be best to describe it now and to follow it with some comments on the family generally, before I enter upon a treatment of other families.

The present contribution will further contain full descriptions of six other forms, partly likewise new and partly before described by me in brief, viz., *Leucopsacus orthodocus* IJ., *L. scoliodocus* IJ., *Chaunoplectella cavernosa* IJ., *C. spinifera* n. sp., *Caulophacus lotifolium* n. sp. and *Sympagella anomala* n. sp. These will be referred to two families newly conceived and proposed for introduc-

tion into the system, *viz.*, the Leucopsacidae and the Caulophacidae. The former group is in part identical with that which I have formerly regarded as a Rossellid subfamily under the name of Leucopsacinae (IJIMA '98, p. 41). The latter corresponds in a large measure to F. E. SCHULZE's Asconematidae, which name will have to be dropped out. Grounds for the above rearrangement will be enunciated in the proper places.



**PLACOSOMA PARADICTYUM.** N. G., N. SP.

Pls. I. and II.

This new genus and species are founded on a single specimen obtained by KUMA in Outside Okinosé, Sagami Sea, from a depth of between 274 and 313 fathoms (501–572 m.).

The sponge is excellently preserved in a dried state, except for a rent across the body; this, however, in no wise prevents us from obtaining a correct conception of the shape. It has a long stalk, which is attached to a brecciated tufaceous substratum by a large, irregularly lobate, basal expansion. Total height of the sponge, 210 mm.

The sponge-body, though probably cup-like when young, can scarcely be called so as it is, but may best be described as an irregular, but transversely elongate and laterally compressed, cake-like mass. It is of a light, soft and very delicate texture. A light touch of the finger is liable to leave behind an impression

on its surface. Length of transverse axis, 243 mm. Breadth in vertical direction, 126 mm. Thickness in the middle, 92 mm.

On account of the compression the body presents two sides, both with uneven, though on the whole convex, surfaces. The margin is by no means thin, being in places quite thick and rounded, while in other places it shows an angular edge-line.

Very remarkable and striking is the difference in appearance presented by the two sides of the sponge-body. Nevertheless, I consider the surfaces of both sides, in fact the entire external surface, as dermal, and therefore as adapted to the afferent passage of water. However, as judged from structural relations, the inflow evidently takes place with special activity, in fact principally, on the one side which may be called the *front* (Pl. I., fig. 1), while the other side, the *back* (fig. 2), seems to allow it only in a relatively insignificant degree and is further characterized by the presence of numerous oscula distributed over it.

The front of the entire sponge is quite destitute of oscula. So far as the smooth and undulating frontage of the body proper is concerned, it is nearly, if not wholly, occupied by a specialized area of the dermal layer, the *frontal lattice*, which consists of open-meshed dermal and hypodermal latticeworks of exquisite beauty. The dermal latticework (Pl. II., fig. 13), in which the laths are supplied by the fine paratangential rays of dermalia, is exceedingly delicate and shows small, regularly quadrate meshes. These measure 150–240  $\mu$  in length of sides. In nature they are easily discernible with the naked eye, but not in the reduced fig. 1, Pl. I., in which however the minutely tessellated pattern may in some parts be observed with the aid of a hand-lens.—The hypodermal latticework, plainly visible in the figure just

referred to, is a much coarser structure and exhibits meshes of a rectangular, trapezoidal, triangular or irregular shape. Within a larger mesh bounded by the stronger beams are inclosed smaller meshes formed by the weaker beams, and all the hypodermal meshes, large and small, are alike overspread by the dermal (or autodermal) layer already described, similarly as in certain Rossellids, Caulophacids, etc. While weaker hypodermal beams appear as simple spicular bundles, stronger ones are in the form of laterally compressed bands. The latter, at the points of junction with the choanosome, expand into vertical plates, which go to form irregular pillars.

The frontal lattice evidently gives support to the ectosome only. It thus differs sharply from the sieve-plate of *Euplectella* or of *Hyalonema*, which structure, in my opinion, is a peculiarly modified part of the sponge-wall in its entire thickness and therefore contains not only the ectosome but also the choanosome (Contrib. I., pp. 38, 66). Moreover, while a sieve-plate always stands in connection with either the principal or the sole place of water exit, it is just the opposite with the frontal lattice, which is developed apparently for facilitating the inflow of water.

Nowhere else is the subdermal space so distinctly and spaciously developed as under the frontal lattice, which fact contributes not a little to the peculiarity of this side. It is especially deep (10 mm. or more) in the middle. In conformity with the wide subdermal space, many of the incurrent canals leading from it are large, some measuring 12 mm. across at the entrance.

The peripheral border of the frontal lattice may practically be considered to coincide with the marginal edge of the body, though at certain parts where this is rounded, it may not reach up to, but stops a greater or less distance short of, the ridge-line. In

some parts of the margin, the lattice simply becomes gradually unrecognizable as such, without a distinct demarkation to delimit it; but the more usual condition is that there exists a rather sharply defined boundary. This consists either in a low and narrow wall-like ridge which is more or less distinctly inclined towards the front, or in that the angular body-edge is gently curved forwards, the concave surface being lined by the lattice up to the very edge and the convex, by the dense-looking covering of the back, presently to be described. The latter condition reminds one strongly of that of the oscular margin in many cup-like Hexactinellids with the outflaring rim.

On the back of the body the surface is much wrinkled or puckered up (Pl. I., fig. 2). Here, as on the entire stalk, a lattice-like arrangement of dermal spicules is not perceptible; the subdermal space is scarcely developed, or at any rate is quite insignificant. The entrances into incurrent canals are, if at all developed, small and indistinct. The dermalia are intimately associated with spicular elements of other categories and serve, together with these, to give to the surface a closely interwoven, opaque appearance. The superficial tissue thus formed is soft and extremely delicate, resembling a pith both in appearance and texture.—Further, this side of the body is, as before indicated, peculiar on account of the presence of oscula. These occur even on the stalk, but are confined to the same side. I distinguish a large primary or main osculum and numerous much smaller oscula of probably secondary origin.

That which I consider the *primary osculum*, is a roundish opening situated on the upper, broad and irregularly rounded edge of the body, well without the border of the frontal lattice.



The opening, with a part of the gastral cavity into which it leads, is seen in fig. 2, Pl. II., near the upper edge and to the left of the median line. It measures 36 mm. or more in maximum diameter. The oscular margin is partly rounded and indistinct, partly thin and wall-like. The gastral cavity may be described as a shallow cup-like depression, not more than 15 mm. deep. Its wall, formed of irregularly latticed strands, presents a somewhat powdery appearance, due to the presence of large numbers of a certain hexaster. On it open a number of large and small, oval or roundish, excurrent apertures, measuring up to 8 mm. in width. Right close to the apertures, the excurrent canals are seen to freely and widely intercommunicate with one another; then, they penetrate deeply into the sponge-mass.—The osculum and the gastral cavity here in question, I am inclined to assume, were formed in a very early period of postlarval development. For a time they must have given to the young sponge a cup-like shape. With subsequent general growth, the cup-wall must have increased so excessively in thickness as to have obliterated the original shape, at the same time breaking through new oscula on the one side, as the need arose. These secondarily formed, or we may say, accessory oscula then seem to be equivalent in a way to the parietal oscula of *Euplectella*, save in this unessential point that they open into the excurrent canal-system, instead of into a common gastral cavity.

The secondary oscula are oval or roundish, and sometimes rather irregularly shaped openings of various sizes. The larger may measure 5 mm. or more across, while some are small perforations about 1 mm. or less in diameter. They are irregularly distributed all over the rough-surfaced back, but somewhat more sparingly on the upper rounded edge of the body. In some

places they lie tolerably close together. The thin and soft oscular rim is as often as not slightly raised in a lip-like manner. The oscula lead either directly into deep going excurrent canals or into such spaces of the excurrent canal-system as lie covered over by only a thin layer of the pith-like sponge-tissue. More than one secondary osculum may open into such a superficial space. This should not be mistaken for a subdermal space; the thin layer over it represents the entire thickness of the sponge-wall, consisting, as it does, of parenchymalia in addition to the dermal layer. If we suppose a number of oscula to have opened through it in close proximity to one another, we should have a structure strictly comparable to the Euplectellid sieve-plate. I believe it contains the chamber-layer in an undulating disposition, in much the same way as we usually see it in the thin marginal rim of cup-shaped Hexactinellids; all the chambers, I think, have apopyles directed away from the external surface and towards the canalar space mentioned above. But this point could not be definitely ascertained by direct observation, on account of the desiccated state of the specimen.

So far as the outward appearance goes, there is a certain resemblance between the back-surface of the present species and the gastral surface of certain other Hexactinellids, the oscula of the former simulating the apertures of excurrent canals opening on the latter. But, from the mode of origin of the gastral cavity, there should constantly exist an essential difference in the relation of the dermal and gastral surfaces to the outer or the inner aspect of the chamber-layer. In the case of a real gastral surface, the apopylar ends of chambers should invariably be turned towards it,—not away from it, as they should be if the surface were dermal.

In general shape the present species may be said to be not unlike a *Caulophacus* species, in which the gastral surface, correctly recognized as such, is so turned outwardly and exposed as to form a part of the external surface. Indeed, by a hurried inspection of the present species, one might possibly be misled into thinking of the area of the frontal lattice as the gastral surface similarly exposed on the outside. But the observer will soon see that structurally the frontal lattice is comparable with the dermal, and not to the gastral, layer of *Caulophacus*. Further, the system of canals communicating with the exterior by openings which I have unhesitatingly called the oscula is completely separate from the other canal-system that leads directly from the space right under the frontal lattice. Unless it be an error to regard the openings just referred to as oscula, the latter canal-system needs but to be considered as incurrent, and it then logically follows that the frontal lattice is a structure calculated to allow the afferent passage of water, which is invariably the character of the dermal latticework.

The stalk belongs to the back-side of the body; at any rate, it arises a good distance apart from, and behind, the lower border of the frontal lattice and is covered all over by a direct and uninterrupted continuation of the pith-like surface of the back. Moreover, as before mentioned, it bears a certain number of secondary oscular openings. I lay some importance on the above facts, as demonstrating at once the dermal nature of the back-side surface, since the stalk surface can not possibly be anything but dermal.

Excepting the soft covering layer, the stalk is firm and compact. It expands above to join the body. It is longitudinally

ribbed, more prominently on the back than on the front. It may be described either as a hollow tube with the lumen running close under the back surface, or as being grooved on this side, which groove is covered only with a thin sheet of the pith-like tissue. The lumen or the groove is evidently a part of the excurrent canal-system. It opens externally by a limited number of secondary oscula, distributed irregularly on the thin covering sheet and therefore only on the posterior side of the stalk (Pl. I., fig. 2.).\*

The large, irregularly lobed, basal disc is likewise soft on the surface but internally quite firm. The covered groove of the stalk extends for some distance on the disc-surface, showing on the cover a few more oscular openings. A certain number of other similar but branching canals are seen to ramify on the disc-surface in a vein-like manner.

The most remarkable features in the organization of the present species lie in the massive development of the body and in the differentiation of a part of the external surface into an area, the frontal lattice, more especially adapted to the reception and passing in of the water than other parts of the same.

As regards the former point, an analogous case seems to be presented by *Malacosaccus floricomatus*, recently described by TOPSENT ('01). In this interesting Euplectellid the body should be solid and provided with a number of orifices—evidently exhalant orifices or oscula—distributed over the external surface. The describer however leaves margin to allow assumption that perhaps the presence of a shallow hollow at the superior extremity, represent-

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\* The small hole seen on the front side of the stalk (Pl. I., fig. 1) is an artificial perforation.

ing a rudimentary gastral cavity, is to be ascribed to the species. If that be true, the species should be said to agree with *Placosoma paradietium* not only in the excessively thick development of the originally cup-like sponge-wall but also in the possession of numerous secondary oscula in addition to the single primary one.

The development of the frontal lattice and the occurrence of oscula exclusively on the opposite side of the body in *Placosoma paradietium* probably stand in relation to the physical circumstances of the habitat favoring the ingress of water on the one side or its egress on the other,—possibly in that the former is exposed to, and the latter sheltered from, a prevailing current. Here again we seem to have to do with a structural arrangement which does not stand quite isolated among the Hexactinellida. So, for instance, in *Semperella schultzei*, as is well known, the external (dermal) surface is differentiated into two sorts of tracts, the afferent and the efferent. The latter may indeed be said to occur here on all sides of the columnar body, but is relatively much more extensively developed on its one side than on the other,—a fact, which seems to have hitherto escaped the attention of observers, but which I have found to hold good for all the specimens examined by me. A closer analogy to the condition that obtains in *Placosoma paradietium* is apparently exhibited by *Poliopogon amadou*, as known to me through F. E. SCHULZE's representations in the Challenger Report. In this form the entire external surface is, in my opinion, to be regarded as dermal, the gastral surface being nowhere outwardly exposed. The discharge of water is effected through orifices which are situated exclusively on the one—the concave—side of the half-rolled lamella-like body. This concave surface has been called by F. E. SCHULZE gastral, which appellation however seems inadmissible in view of



the fact that the subjacent chamber-layer shows the blind chamber-ends all directed towards it, similarly as on the convex side (Chall. Rep., Pl. I., fig. 1). It is then plain that the inflow of water takes place all over the surface of both sides, except of course at the separate excurrent orifices on the concave side. The condition of this side then exactly corresponds to that on the back of *Placosoma paradictyum*, while the convex side may be said to correspond to the front, though it lacks a special structure like the frontal lattice.

### Spiculation.

(Pl. II.).

First let me complete an account of the spiculation in the sponge-body proper.

Of the *parenchymalia* the predominating form is a fine diactin, generally 2–8 mm. in length. The breadth, not exceeding 15  $\mu$ , remains nearly the same throughout; not seldom however it slightly increases towards both extremities. These are usually bluntly pointed; the surface near them is nearly smooth or obsoletely rough on account of insignificant tubercles. The center of the diactins is generally quite smooth, and exceptionally marked by an annular swelling or by knobs in cruciate arrangement. The diactins are disposed partly irregularly or in loose indefinite groups and partly in long, compact and thread-like fascicles of variable strength (Pl. II., fig. 15). The hypodermal beams of the frontal lattice (see fig. 13) are nothing else than extensions of such parenchymal fascicles from the choanosome.—Among the parenchymalia making up the



fascicles there are none which, on account of a specially emphasized size or strength, may be distinguished as the principalia. Nor does there exist synapticular fusion among any of the parenchymalia, so far as those of the main body are concerned.— Besides the diactins there also exist, among the parenchymalia, a number of medium-sized hexactins in sparse distribution (see fig. 15). Occasionally these are represented by forms more or less closely approaching a pentactin or even a stauractin in form. Axial length up to nearly 1 mm.; thickness of rays near base up to  $20\mu$ ; the rays gradually taper towards the free end, which is faintly rough-surfaced and either sharply or bluntly pointed. The rays in a spicule are often of unequal lengths. In some cases one of the axes was found to be prolonged more or less in comparison with the rest, and with that elongated axis the spicule took part in the composition of a parenchymal fascicle; but the rule is that the hexactins stand in no definite relation with other parenchymal spicules as regards the situation of their rays.

The parenchymal hexactins are, in point of size and shape, not always sharply distinguishable from those hexactins which may be called the *canalaria*. These are found sparingly and isolatedly in irregular distribution on the canalar surface as well as on the hypodermal beams of the frontal lattice. Two of them are seen in the lower part of fig. 13, Pl. II. They are recognizable as such only when one of the six rays is considerably shorter than the rest and projects freely, from base to tip, into the canalar lumen or the subdermal space. The free ray shows, though not always, a further specialization in that it has a rounded termination, instead of being pointed like the other rays.

The dermalia and the gastralia are likewise spicules whose shape and size present points of approach to the parenchymal hexaetins.

The *dermalia* are hexaetins, in part somewhat sword-like in shape as in the generality of the Euplectellid members, but in part much flattened owing to an extensive shortening of the proximally directed blade-ray. In details of characters they differ somewhat according as they are located on the front or on the back of the sponge-body.

First, the dermalia of the frontal lattice (Pl. II., figs. 1 and 2). The rays measure about  $9\mu$  in breadth near the spicular center. The distal free ray is always very short, being only  $45\text{--}55\mu$  and seldom  $65\mu$  in length; it usually broadens slightly towards the distal end, which is rounded and has a surface supplied with quite insignificant microtubercles. The paratangential rays are  $150\text{--}200\mu$  long, as measured from the center; they taper outwards in a barely perceptible degree, to terminate with rounded or bluntly conical tips; the surface is sprinkled with obsolete microtubercles which are distributed more densely near the end of the rays. The proximally directed ray resembles the paratangentials in general appearance but is subject to great variation as to its length, according to the position of the dermalia in the frontal lattice. Where there exists a hypodermal beam directly underlying the dermal layer, the spicules of the latter have a more or less elongated proximal ray dipping right into the substance of the former. That ray is then considerably—at times even thrice—longer than a paratangential of the same spicule (Pl. II., fig. 1). Whereas, within a mesh-area bounded by hypodermal beams, *i. e.*, in parts where the dermal layer has no skeletal support underneath, the dermalia have their proximal

rays greatly reduced in length (Pl. II., fig. 2) In extreme cases, this ray may be only about as long as the distal ray and similarly club-like in appearance. So far as the dermal layer is made up of such—so to say, flat—hexactins, it stretches freely over the wide subdermal space without any spicular connection with the choanosome. Similarly flattened dermalia, occurring under the same circumstances, have been described by me from *Regadrella komeyamai* among the Euplectellidae (Contrib. I., p. 261).

The dermalia on the back of the sponge-body are all supplied with a proximal ray which is always the longest of the six, the dermal layer on this side being everywhere in close connection with the choanosomal mass. Under a general agreement in appearance, they differ slightly from those of the frontal lattice in being on the whole larger and in the rays being somewhat more tapering and having a nearly smooth surface except for a short space at the end. Breadth of rays up to  $10\ \mu$  near the spicular center. Distal ray  $70\text{--}100\ \mu$  long; swollen towards the rounded end. Paratangentials  $220\text{--}300\ \mu$  long. Proximal ray may be twice as long, or longer.

In the frontal lattice the paratangentials of separate dermalia are as a rule closely apposed to one another to form the exquisite checker-like latticework (fig. 13). On the back of the sponge this arrangement is carried out to a certain extent but not with the same degree of regularity (fig. 14). Here the separate dermalia generally lie wider apart and at places show no order as to the relative disposition of their paratangentials.

The *gastralia* (Pl. II., figs. 3 and 16), found in irregular distribution over the gastral surface inside the main osculum, are hexactins. They resemble in appearance the dermalia of the

back. Length of the longest—the radially directed—axis, 600–800  $\mu$ . Paratangentials 200–260  $\mu$  long. The free gastral ray is of about the same length, or shorter; it is not always rounded at the end, but may be gradually tapering and conically pointed like the other rays. Thickness of rays near base  $7\frac{1}{2}$ –8  $\mu$ .

The *hexasters* of the species belong all to one type, the discohexaster; but this occurs in no less than three varieties of markedly different characterization, *viz.*, the hexactinose discohexaster, the spherical discohexaster and the hexactinose codonhexaster. Floricomes and graphiocomes are not present.

By far the most abundant and the most generally distributed are the small *hexactinose discohexasters* (Pl. II., figs. 4 and 7). They are very numerous about the hypodermal beams of the frontal lattice and everywhere in the parenchyma (see figs. 13–16). The manner of their distribution in large numbers reminds one of that of micramphidises in certain Amphidiscophora. The size is subject to considerable variation. In most cases the diameter measures 30–60  $\mu$ , on an average about 46  $\mu$ ; but occasionally, and especially near the back surface of the sponge, the hexaster attains a much larger size, reaching 100  $\mu$  in diameter. The axial filaments in the central node extend, as determined by direct observation, only to the base of the six moderately strong rays. The watchglass-like or nearly hemispherical terminal disc measures 8–15  $\mu$  across; its well developed marginal teeth vary from 8 to 15 in number, according to the smaller or larger size of the spicule. In some rare instances I have found the terminal disc unusually small and toothless, a condition which is probably to be considered as representing a stage in its developmental history. Also a few cases of hemihexasterous forms, such as are

shown in figs. 5 and 6, came under my observation. It seems that through these forms the small hexactinose variety of hexasters now in question passes over gradationally into the spherical discohexaster next to be described. On the other hand, there not infrequently occur, especially near the surface of the back and of the gastral cavity, such forms as bridge over the gap between the present variety and the hexactinose codonhexaster (fig. 8). The intermediate forms just referred to are generally somewhat larger than usual and possess terminal discs, which, by elongation of the marginal teeth, have acquired a more or less bell-like shape.

The *spherical discohexasters* (Pl. II., figs. 9–12) are large and of great beauty, most closely resembling those that are known from *Dictyaulus elegans* F. E. SCH. I have found them only close to the dermal layer on the back of the sponge, where they occurred abundantly in some places (see fig. 14), but only occasionally in others. They mostly measure 160–240  $\mu$  in diameter. From the expanded end of each short and stout principal there arise in the smaller rosette 4 or 5 terminals and in the larger ones 12 or thereabout. They are not always arranged in a whorl, but often one or more are seen to spring from a position inside the points of origin of the peripheral ones. The slender terminals thicken considerably at the outer end and are capped with a strongly convex disc, which may measure up to 23  $\mu$  in diameter. Of the well developed marginal teeth there are 10–13, sometimes more (up to 17), to a disc. All the terminal discs in a rosette of the kind are approximately equidistant from one other, so that a spherical form is given to the entire spicule.—Special mention must be made of unusually small, normally developed, but only occasionally occurring discohexasters which seem to lead



the large spherical discohexaster gradationally over to the small hexactinose discohexaster before described, especially to the hemihexasterous form of this rosette. We have here to do with spherical discohexasters of under  $150\ \mu$  diameter, leading down to  $100\ \mu$  or less (even to  $55\ \mu$ ). Fig. 9, Pl. II., represents one such case, measuring about  $100\ \mu$  in diameter. Two or three, sometimes four, terminals belong to a principal; the terminal disc is just the same as in a small hexactinose discohexaster.—Noteworthy also seem the cases—quite rare though these are—of certain moderately large ( $132\ \mu$  diameter) discohexasters in which 4 or 5 terminals, each ending in a bell-shaped terminal disc, belong to each principal (see fig. 10). Here is apparently an approach of the normal discohexasters to the hexactinose codonhexaster next to be described; but an intermediate hemihexasterous codonhexaster has not been met with.

The *hexactinose codonhexasters* (Pl. II., figs. 11, 16) occur in great abundance just under the gastral layer. The powdery appearance, before noticed, of that layer is due to their crowded presence. They are also found in the parenchyma generally, but only quite seldom and at wide intervals. Diameter in most cases  $110$ – $176\ \mu$ . The slender hexradiate rays, arising from a small central node, are usually more or less bent. Here again the axial filament of the central cross extends, as a matter of fact, only a very short distance into the base of the rays. The deeply bell-like terminal umbel may be  $30\ \mu$  broad and  $42\ \mu$  long; the long teeth of the sides 12–16 in number. I have already indicated that this category of the hexasters is connected with the small hexactinose discohexasters by forms that are intermediate both in point of size and of the shape of the terminal disc.



Finally, as to the spiculation of the stalk and of the basal disc.

In both these parts the main mass of the parenchyme is rigid and consists of long, synapticularly connected diactins, measuring  $10-40\mu$  in thickness. These run in longitudinal bundles in the stalk, while in the disc they are disposed more or less parallel to the surface but otherwise in all directions. Hexasters among the fused parenchymalia seem to be rarely present.

Towards the external surface, in both the stalk and the disc, the synapticulæ cease to exist. The peripheral diactinic parenchymalia thus left loose and unconnected, together with the dermalia and the hexasters present, form a soft tissue which in a thin layer covers the entire external surface of the parts in question, besides constituting the substance of the thin oscula-bearing sheet which partially shuts off the large excurrent canals from the exterior (see p. 9).

The dermalia of the stalk compare well with those of the body, except in often having the distal ray considerably reduced in length, sometimes even to a mere knob or a gentle swelling. And, lower down the sponge, *i.e.*, on the disc-surface, this ray is completely lost in all, so that here the dermalia are pentactinic, —a condition which may possibly represent the state as assumably obtains in the entire dermal layer of the species in the earliest period of postlarval development, as I have found to be the case in young *Regadrella okinoseana* (see Contrib. I., pp. 246, 247). In all the dermalia the proximal ray, penetrating into the underlying tissue, is always the longest. Seen on the surface, the paratangential crosses lie rather densely crowded, without any regularity as to their relative position.

The hexasters in the said soft tissue of the periphery are

the small hexactinose and the larger spherical discohexasters, both of exactly the same characters as those of the body. The former are common everywhere, while the latter have been found scattered here and there in the stalk only.

The large excurrent canal in the stalk is likewise lined with a thin layer of fine diactinic parenchymalia, free of synapticular formations. No special canalaria exist here, but the hexasters are represented by the usual, small, hexactinose discohexaster and the hexactinose codonhexaster of a larger size—the former in excessive abundance but the latter only sparsely. It may be pointed out that the presence of the codonhexasters along the canalar wall manifests a point of agreement, and indicates a direct continuity, between the surfaces of that canal and of the gastral cavity, in a manner as it is perfectly natural to find, as we did, the same spherical discohexaster under the continuous dermal surfaces of the stalk and of the back of the sponge-body.

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*Observations on the Euplectellidæ generally.*

As to the systematic position of *Placosoma paradictyum*, it is safe to say that it should be placed under the Euplectellidæ. In an attempt to determine, as nearly as possible, its position within that family, I have been led to undertake a renewed study of all the members of the family as regards their known systematic characters, and this induces me to make here some observations concerning the family diagnosis and the division into subfamilies, and in this connection I take the opportunity to modify certain

statements that I made prematurely in Contribution II. with respect to the Euplectellid subfamily Corbitellinae.

It may be well to preface my remarks by an enumeration of all the genera that I consider as making up the family as it now stands. These are as follows:

- |                                     |                   |
|-------------------------------------|-------------------|
| 1. <i>Holascus</i> F. E. SCH.       | (With 8 species). |
| 2. <i>Malacosaccus</i> F. E. SCH.   | ( „ 3 „ ).        |
| 3. <i>Euplectella</i> OWEN.         | ( „ 13 „ ).       |
| 4. <i>Regadrella</i> O. SCHM.       | ( „ 3 „ ).        |
| 5. <i>Corbitella</i> GRAY.          | ( „ 3 „ ).        |
| 6. <i>Heterotella</i> GRAY.         | ( „ 1 „ ).        |
| 7. <i>Walleria</i> F. E. SCH.       | ( „ 2 „ ).        |
| 8. <i>Dictyaulus</i> F. E. SCH.     | ( „ 1 „ ).        |
| 9. <i>Dictyocalyx</i> F. E. SCH.    | ( „ 1 „ ).        |
| 10. <i>Hertwigia</i> O. SCHM.       | ( „ 1 „ ).        |
| 11. <i>Trachycaulus</i> F. E. SCH.  | ( „ 1 „ ).        |
| 12. <i>Saccocalyx</i> F. E. SCH.    | ( „ 1 „ ).        |
| 13. <i>Rhabdoplectella</i> O. SCHM. | ( „ 1 „ ).        |
| 14. <i>Rhabdodictyum</i> O. SCHM.   | ( „ 1 „ ).        |
| 15. <i>Hyalostylus</i> F. E. SCH.   | ( „ 1 „ ).        |
| 16. <i>Placosoma</i> IJ.            | ( „ 1 „ ).        |

The family diagnosis, as given by F. E. SCHULZE ('99, p. 97) in the latest period, runs as follows:

“Röhren-, sack- oder kelchförmige Hexasterophora, welche entweder mit einem basalen Nadelschopfe im Boden wurzeln oder, sei es direkt, sei es mittelst eines langen röhrenförmigen Stieles, aufgewachsen sind. Die Dermalmembran wird gestützt durch hexactine Hypodermalia, deren Proximalstrahl in der Regel verlängert ist.”

Excellent as this diagnosis is on the whole, I think it may perhaps with advantage be somewhat remodelled in order the more sharply to characterize the family. In fact, this seems necessitated to a degree by the discovery of new forms since the above diagnosis was drawn up. In attempting the revision, it is to be borne in mind that of all the lyssacine families it is especially the Caulophacidæ (for which, *vide* a later paragraph in this Contribution), with which the Euplectellidæ, as bearing closest resemblance in certain important systematic characters, require to be placed in contrast. Now, the more important points not indicated or explicitly mentioned in the above diagnosis F. E. SCHULZE's but which appear to call for our attention here, seem to be the following.

1. The massive development of the body in *Malacosaccus floricomatus* TOPS. and *Placosoma paradictyum* IR., neither of which can be said to be tubular, saccular or cup-like.

2. The presence of a distinctly stalk-like part in the body of *Malacosaccus floricomatus*, running out into a tuft of anchoring spicules at the inferior end. The stalk is then a thing, the occurrence of which is not confined to those Euplectellids which at base are firmly fixed to the hard substratum.

3. The Euplectellidæ, excepting a few insufficiently known forms (*Malacosaccus vastus*, *M. unguiculatus*, *Hertwigia*, *Hyalostylus*), as a rule exhibit on the parietes a large number of separate orifices (oscula) for the discharge of water. It is common to find them all (*Holascus*) or in part (*Euplectella*, *Corbitella*, etc.) in close congregation (forming the sieve-plate meshes) at the superior end of the body, whereby is brought about a condition which simulates such other cases as show a single large terminal osculum with (e.g., *Placosoma paradictyum*) or without (e.g., *Malacosaccus*

*unguiculatus*) a greater or less number of additional oscula on the lateral wall. The multiplicity of oscules is certainly not a peculiarity of the Euplectellidæ; and moreover, cases are not wanting in this family which indicate that we have here to do with a very variable character, sometimes apparently of no more than specific, or at most generic, value. Nevertheless, it seems undeniable as a general fact that the tendency toward that character is, in the Euplectellidæ, brought into expression with such a degree of constancy and accentuation as is foreign to any other lyssacine hexasterophorous family (Leucopsacidæ, Caulophacidæ, Rossellidæ). And further, it is a noteworthy feature that on this account the appearance of individuality is not generally in the least impaired. Whereas, in the Caulophacidæ, the formation of additional oscula in an individual is always in connection with a process of budding, thus imparting to it a more or less cormus-like or "polyzoic" appearance.

4. The dermalia (=F. E. SCHULZE's Hypodermalia) in the Euplectellidæ may be said, as a general matter of course, to still remain in a comparatively incipient stage of morphological differentiation.\* Thus, they stand in direct and intimate relation with the parenchymalia in that the proximal ray dips right into the choanosome; they are known in some cases even to intergrade in the characters of rays with certain hexactinic parenchymalia. On the other hand, in the Caulophacidæ—and, I may add, in the Rossellidæ—the corresponding spicules (*i.e.*, the autodermalia) apparently represent a more highly specialized category of spicules which are joined to the parenchymalia only through the inter-

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\* This condition of the dermalia is shared in a way also by the Leucopsacidæ, in which however the dermalia are pentactins or are at any rate always wanting in distally directed rays.



mediation of the hypodermalia, especially the large pentactinic hypodermalia. Amongst the Euplectellids, the hypodermalia are thus far known only in the frontal lattice of *Placosoma paradictyum* but in no case have hypodermal pentactins been found. Here is, I think, an important negative character which distinguishes the family from such others as are most liable to be confounded with it.

After what I have said above, the diagnosis may be made so as to read somewhat as follows:

Lyssacine Hexasterophora\* of tubular, cup-like or massive body; sometimes stalked; either rooted by a tuft of basal spicules or firmly attached by compact base; generally possessing numerous separate oscula. Dermal skeleton composed of hexactinic dermalia, the proximal ray of which is as a rule much longer than any other in the same spicule; no hypodermal pentactins. Hexasters various.

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\* I adopt F. E. SCHULZE'S ('99, p. 93) system of dividing the Hexactinellida—the living Hexactinellida, at least—into two great primary groups or suborders, the Amphidiscophora and the Hexasterophora. Here, as elsewhere in this paper, the term “lyssacine” is used without implying the Lyssacina as a systematic group, but merely to denote the condition of those Hexactinellids, in which the parenchymalia are all or mostly free and unfused, or in which these may sometimes be extensively ankylosed and then consist not exclusively of hexactins, but of hexactins and their derivative forms or of the latter only. The term “dictyonine,” as employed by me, refers to the state of those Hexactinellids in which the parenchymalia, consisting of hexactins, and as a rule of hexactins only, undergo fusion among themselves from a very early period of their existence. A brief exposition of my views on the Hexactinellid phylogeny and system, incomplete and somewhat provisional as these necessarily are in the present stage of my studies, may help to clear up the points in question, and may at the same time serve to indicate the position of the different families described in this Contribution.

For the ancestral Protohexactinellida is to be assumed a *lyssacine* form, in which the spicules consisted, mainly at least, of more or less regularly developed hexactins. Now, the Amphidiscophora should represent a very early differentiated branch of the Hexactinellida, which has remained thoroughly lyssacine in character and has been, on that account, in a position to give rise to such manifold variations of triaxonie spicules as we see in that group.

Now as to the division of the Euplectellidæ into subfamilies. Of these, three have been recognized by F. E. SCHULZE ('99, p. 97), *viz.*, the Holascinae, the Euplectellinae and the Tægerinae.

The Hexasterophora, it seems safe to say, should have had for its prototype a form which was firmly attached by its base to the hard substratum. Whenever a Hexactinellid is thus fixedly seated, even though it be a so-called Lyssacina, it is quite generally true that certain small hexactinic spicules occurring at the base very early undergo fusion, beginning with those in direct contact with the substratum, thus bringing about a typically dictyonine framework at the part. This might have taken origin in consequence of the sponge requiring a certain degree of firmness at the part of attachment. That rigid framework, so far as it occurs in lyssacine Hexactinellids, I have called the *basidictyonalia* (Contrib. I., pp. 186 [foot-note], 232 and 264). The same framework it is, I hold, which has reached the most extensive development in the so-called Dictyonina and has been called by F. E. SCHULZE the *dictyonalia*. The basidictyonalia and the dictyonalia I consider as genetically and morphologically identical. Both retain a primitive character in that they alike consist, as a general rule, of hexactins only, although derivative forms of spicules with a smaller number of rays may secondarily come into fusion with the beams. The true dictyonine skeleton as here specified, should be kept distinct from another kind of ankylosed framework in which the elements involved are not solely hexactins, but principally derivatives of the same, such as stauractins, tauactins, diactins, etc. (as, e.g. in the rigid skeletal frame of the lateral wall or the stalk in the *Euplectellinae*). The rigidity in the latter case is clearly a much later acquisition than that in the basidictyonalia or the dictyonalia. For, before the ankylosing process, starting at the base, has encroached upon the parts occupied by the derivative spicules indicated, these must have had a long period of loose existence during which they should have derived their shape from the original hexactinic form,—which would be impossible had they been soldered together beforehand. From this standpoint, the well-known skeletal framework of f.i. *Euplectella aspergillum*, notwithstanding the completely ankylosed state of its component spicules, ought not to be confounded with the basidictyonalia or the dictyonalia of certain other Hexactinellids but should fall under the lyssacine category, in which the ankylosis has but secondarily set in.

But to return to the Hexasterophora prototype. I consider this to have already possessed at its base a basidictyonal mass in addition to the loose spicules of the body proper, which were directly inherited from the Hexactinellid ancestor. In other words, it may be said that the skeleton was partly dictyonine and partly lyssacine in character,—a dual condition, which, in general, may be said to obtain in all the recent Hexasterophora, if we except those forms which have apparently lost the basidictyonalia in secondarily adapting themselves to the special mode of attachment by means of anchoring spicules (*Euplectellinae*, *Lophocalyx*, *Melonymphe*). During the phylogeny, the elements of the dictyonine portion have remained essentially unchanged in character, as they should owing to their rigidly fixed state. On the other hand, those of the lyssacine portion have been capable of adapting themselves in manifold ways to varied conditions of existence, analogously to the similarly circumstanced spicules of the Amphidiscophora, the result being the multifarious hexactin-modifications—amongst them the hexasters—which we meet with in the Hexasterophora.



Whether or not the Holascinae, made up of the two genera *Holascus* and *Malacosaccus*, and the Euplectellinae, consisting of the single genus *Euplectella*, are to be kept separate, is, I should think, largely a matter of opinion. To me it appears that the two subfamilies had better be united into one, chiefly because the main distinctive character that has been assumed as existing between them,—viz., the absence or presence of orifices on the lateral wall,—has been discredited by the recent discovery of *Malacosaccus floricomatus* TOPS., in which a number of orifices,

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Whether or not the paleozoic lyssacine forms, put together by SCHRAMMEN ('02) under a distinct suborder, the Stauractinophora, are to be looked upon as really representing a phylum systematically nearly equivalent to the Amphidiscophora or the Hexasterophora, I prefer to leave undecided, owing to uncertainties that always attach to the fossil Hexactinellids in respect of the finer spiculation.

The Hexasterophora I assume to have early split into at least three branches or tribes, to be here provisionally called A, B and C.

Tribe A, which may be allowed to retain ZITTEL's name Lyssacina but in an altered sense, comprises all the hexasterophorous lyssacine families, of which I distinguish four, viz., Euplectellidae, Leucopsacidae, Caulophaeidae and Rossellidae.

The other two tribes are both dictyonine and together correspond to ZITTEL's Dictyonina, but are probably not to be put together under one such systematic group.

Under Tribe B, which in scope nearly agrees with F. E. SCHULZE's Inermia, I place the family Dactylocalycidae (made up of the genera *Dactylocalyx*, *Margaritella*, *Myliusia*, *Autocalyx* and *Euryplegma*) as well as all the lychniscophorous forms, both recent and fossil. SCHRAMMEN (*l. c.*) though essentially in agreement with F. E. SCHULZE and with me as regards the principles of classification, stands in practice at variance with the view here advanced in that the Lychniscophora SCHR. is made by him into a suborder distinct from another, the Hexactinophora SCHR., which latter is made up of the Tribes Amphidiscophora, Hexasterophora and Uncinataria. That writer evidently lays undue weight on the lychnise. This in my opinion is formed simply by the addition of peculiarly arranged synaptienae around the central node of hexactins composing an ordinary dictyonal skeleton. The Lychniscophora then seems to me to be just as much a Hexactinophora as any form referred by SCHRAMMEN to this group. And furthermore, it is certainly a Hexasterophora, as is proved by what we know of the living lychniscophorous genus *Autocystis*.

Tribe C is exactly identical with F. E. SCHULZE's Uncinataria. The spicules called uncinates, from which the tribe received the name just mentioned, are peculiar in that they can not be proved to be secondarily derived from a triaxon owing to the absence of the axial cross, though the axial canal is present. A noteworthy fact it is that the same spicules occur also in certain Amphidiscophora, though not in all. This seems indicative of a near phylogenetic relation between the Uncinataria and the Amphidiscophora, but just how it is scarcely possible to determine.

apparently fundamentally the same as those seen in *Euplectella*, are found distributed all over the body. At any rate, the system suffers no disadvantage if the Euplectellinæ, consisting, as it does, of only a single genus, be deprived of its doubtful status as a distinct subfamily; and moreover, the group resulting from the above amalgamation seems to be a perfectly natural and well defined one, representing a Euplectellid phylum which has adapted itself to a special mode of attachment to the soft or loose sea-bottom. For this new group or subfamily, the name Euplectellinæ may however be retained but in a new sense, as follows: Euplectellidæ rooted in the substratum by a tuft of basal spicules.

Setting aside the three genera that make up the Euplectellinæ as defined above, the remaining genera (13 in number, *vide* the list on p. 20) are, assumably all and without exception, those forms which are directly and firmly fixed at base to the hard substratum,—probably the primitive mode of attachment of the Euplectellidæ.

This assemblage of genera includes all those that were referred to the Tægerinæ by F. E. SCHULZE, besides others which have been left by him unassigned to any of the subfamilies as being too insufficiently known (F. E. SCH., '87, p. 99). In my last Contribution (Ij., '02, p. 30) I had, for what I considered a necessity by usage, substituted the name Corbitellinæ for that of Tægerinæ, to which change I still adhere; but the scope I had given to the subfamily, though on the whole much more extended than before, was in one respect narrowed, *viz.*, in that the genera *Hertwigia*, *Trachycaulus* and *Saccocalyx*, all placed by F. E. SCHULZE ('99, pp. 96-98) among his Tægerinæ, were not included in my list of the Corbitellinæ then given (Ij., *l. c.*). It may

supplementarily be explained that the omission was made under the impression that a distinct subfamily should be instituted to receive the genera mentioned, together with certain others. I have since come to see that this is not practicable; in fact, all the firmly seated Euplectellids known at present now seem to me to form a group, which admits of no subdivision so as to represent more than one phylum. This is especially on account of the intricate manner in which certain highly characterized hexasters are distributed among, and combined in, the different genera. So that, after all, they can not but be left to stand as one subfamily, the Corbitellinæ, in contrast with the only other subfamily, the Euplectellinæ, of the family under consideration. The Corbitellinæ may then be characterized simply as: Euplectellidæ firmly attached to the substratum by compact base.

It goes without saying that the definition of the Corbitellinæ as it stands in my Contribution II. and the list of the species appended thereto are rejectable, the former as going too much into particulars and the latter as being incomplete.

Inseparably linked together as the Corbitelline genera apparently are, the series may nevertheless be said to show a general tendency of development in two directions. At the one end of the series may be placed those forms, which, like *Regadrella*, *Corbitella* and the like, are of a tubular shape having the sieve-plate and possessing both the floricome and the graphicome among the hexasters. *Euplectella*, and with it the Euplectellinæ, represents in all probability an off-shoot by special adaptation somewhere from this end of the Corbitelline series. At the other end may be placed those forms, e. g., *Dictyaulus*, *Hertwigia* and *Saccocalyx*, which, under variable external shapes, have given rise to such special hexaster-modifications as the discospiraster, the

codonhexaster, the aspidoplumicome, or the drepanocome, while the graphiocome, alone by itself or together with the floricome, has either been lost or has never come into development. *Placosoma paradietum*, as being in possession of codonhexasters and wanting in both floricomes and graphiocomes, seems to have its position somewhere in the latter end of the Corbitelline series, though it is difficult to indicate to which of the genera it is most nearly related.

The division of the Corbitellinae somewhat in the manner hinted at above may become possible and even necessary in the future; for a far wider knowledge than we at present possess is to be taken in prospect, when we remember that most of the genera are now known only in solitary species and that too, in so many cases, in a single specimen.



## LEUCOPSACIDÆ.

In '98 (p. 41) I introduced into the system a group by the name of Leucopsacinae, to which the status of a subfamily under the Rossellidæ was given. It is herewith made a distinct family with some change in its scope and definition.

To the Leucopsacinae, as a Rossellid subfamily, I originally referred the following six genera :

1. *Leucopsacus* IJ. (With 2 species, *L. orthodocus* IJ. and *L. scoliodocus* IJ.).
2. *Chaunoplectella* IJ. (With 2 species, *C. cavernosa* IJ. and *C. spinifera* n. sp.).
3. *Caulocalyx* F. E. SCH. (With 1 species, *C. tener* F. E. SCH.).
4. *Placopegma* F. E. SCH. (With 2 species, *P. solutum* F. E. SCH. and *P. sp.*).
5. *Aulocalyx* F. E. SCH. (With 1 species, *A. irregularis* F. E. SCH.).
6. *Euryplegma* F. E. SCH. (With 1 species, *E. auriculare* F. E. SCH.).

I now think that the two last named genera, *viz.*, *Aulocalyx* and *Euryplegma*, had better be separated from the group in question as well as from the Rossellidæ altogether and placed under a dictyomine family, Dactylocalycidæ, together with *Dactylocalyx*, *Margaritella*, and *Myliusia*.\* I am led to this conclusion chiefly by reason of an essential agreement in the characters of

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\* With *Myliusia* GRAY is probably identical? *Scleroplegma* O. SCHM.

the dermalia and of the parenchymalia made up of hexactins, and of *hexactins only*, which are quite extensively ankylosed except in growing parts of the body. It may be remarked that, through the two genera herewith united to the Dactylocalycedæ, this family is brought into close relationship with the lyssacine family which I shall call the Leucopsacidæ.

The four remaining genera, *viz.*, *Leucopsacus*, *Chaunoplectella*, *Caulocalyx* and *Placopegna*, are all lyssacine forms, but should likewise, I think, be removed from the Rossellidæ on account of a somewhat marked difference in the nature of the dermal skeleton, a point to which we give, rightly I believe, much weight in distinguishing the families. The removal would be an advantage to the system in this respect, that the Rossellidæ is thereby left a group much more uniformly characterized than before, in that its dermal skeleton may then be said to be uniformly composed of well differentiated, small, rough-surfaced dermalia and of much larger, supporting spicules, the hypodermalia, which are generally pentaactins much less specialized in characters from certain parenchymalia. On the other hand, the four genera in question have all relatively large *pentaclinic* dermalia with which are associated *no* spicules that may be called the hypodermalia. Owing to this character they can not, in my opinion, very well be received into any known lyssacine family. However it may be said that in general features of the dermal skeleton, as in fact in general spiculation, they most closely resemble, and therefore show nearest relationship to, the Euplectellidæ, but of course with this difference that the dermalia lack the distally directed, sixth rays which are always present in those of the family just mentioned. If they should perforce be united to any of the accepted families, the union must be with the Euplectellidæ and



not with any other family. The absence of distal rays to the dermalia, it may be said on theoretical grounds, is simply due to a secondary loss, which might be easily conceived if we remember the great variability of the corresponding spicules within the family Rossellidæ. It may be that the pentactinic dermalia, as represented in quite young *Regadrella okinoseana* (IJ., '01, p. 240) probably as the result of adaptation to certain secondary circumstances and which in this Euplectellid are soon overcrowded by later formed hexactinic forms, have in the present cases become permanent under the continuance of the same adaptive conditions. It is certainly not to be excluded that hexactinic dermalia develop in certain limited parts of the body-surface; thus, in *Placopegma solutum*, according to F. E. SCHULZE ('95, p. 64), the dermalia on the oscular margin are hexactins, instead of pentactins as on the general surface. At all events it appears justifiable to assume that the four genera under consideration, whether separately or as a group, were derived either secondarily from the Euplectellidæ or from an early prototype of the same. With the progress of our knowledge in the future, it may become necessary to incorporate them all or in part in the family just referred to; but meanwhile, I consider it expedient to keep them separate in a distinct family, to be designated the Leucopsacidæ, even if only to avoid disturbing the integrity of the Euplectellidæ as already defined.

As regards the genera *Leucopsacus* and *Chaunoplectella*, it seems nothing stands in the way of regarding them as forming a systematically coherent group which may have very early diverged from the Euplectellid Corbitelline phylum. But now, in associating with them the genera *Caulocalyx* and *Placopegma* in one taxonomic group, I am not without misgivings as to whether

a polyphyletic character is not thereby given to it. As to *Caulocalyx*, the presence of aspidoplunicomes (F. E. SCH., '97, p. 549)—the same peculiar hexasters as those found in *Hertwigia* and *Saccocalyx*—indicates its affinity with these highly organized Corbitellinæ and so suggests that it had an origin later than, and independent of *Leucopsacus* and *Chaunoplectella*. With respect to *Placopegma*, should F. E. SCHULZE's ('95, p. 65) assumption of the presence of a basal anchoring tuft prove correct, the genus must probably be regarded as derived from the Euplectellinæ, and not from the Corbitellinæ as is the case with the other genera. The barbed anchor-needles that were discovered in *P. solutum* have been assumed by F. E. SCHULZE (*l. c.*) to be pentactinic, each of the four anchor-teeth being taken for a real spicular ray; but this seems to me highly improbable. The short transversely disposed axial filaments forming a part of the central cross in the said needle (*l. c.*, Taf. VI, Fig. 16) are far from extending into the anchor-teeth and appear much too abortive to allow of these being interpreted as real rays, but they are only of such a degree of development as we see in a diactin or a monactin of a similar strength; so that, I think, the anchor-needle is essentially comparable to that of the Euplectellinæ, save in this relatively unimportant respect that the central axial cross is brought down into the inferior swollen end, instead of being situated some distance above it.

Under the above circumstances it is with a certain degree of reserve that I place *Placopegma*, and *Caulocalyx* also, although with somewhat less care, under the Leucopsacidæ together with *Leucopsacus* and *Chaunoplectella*. I think the family may be made to stand on the strength of the two last mentioned genera alone, if it should become necessary to remove the other two

from it. For the present I consider it preferable to include all the four genera in the Leucopsacidæ, which may then be diagnosed as follows:

Lyssacine Hexasterophora of thick-walled, cup-like or ovoid body; sometimes stalked; firmly attached by base (? or rooted by basal spicules). Dermal skeleton composed as a rule of moderately large pentactins with the unpaired ray directed proximad; hypodermalia not distinguishable. Hexasters represented mainly by discohexasters (no oxyhexaster).

A key to the genera and species, which should also show in a way the structural peculiarities of each, may properly be appended here.

- a.*—With hexactinose forms among the discohexasters. Gastralia hexactinic, similar to parenchymal hexactins. Sponge-body small.....Leucopsacus.
- a*<sup>1</sup>.—Other discohexasters with terminals in a distinct group to each principal. Parenchymal hexactin with straight rays. Body stalked.....*Leucopsacus orthodocus*. (Sagami Sea).
- b*<sup>1</sup>.—Other discohexasters generally spherical in shape. Parenchymal hexactin with more or less bent rays. Not stalked.....*Leucopsacus scoliidocus*. (Sagami Sea).
- b.*—Without hexactinose discohexasters. Sponge-body of a considerable size.
- c*<sup>1</sup>.—The larger discohexaster with terminal prongs arranged in a whorl like anchor-teeth. Gastralia hexactins .....*Chaunoplectella*.
- a*<sup>2</sup>.—Dermalia of not only pentactins but also other forms without distally projecting rays. Discohexaster may be as large as to measure 250–400  $\mu$  in diameter. Small and delicate sigmatocomes present on the tip of the outstanding ray of canalaria .....*Chaunoplectella cavernosa*. (Sagami Sea).
- b*<sup>2</sup>.—Dermalia always pentactins, some of which have paratangentials sparingly supplied with bent spines on the outer surface. Discohexaster not larger than 114  $\mu$  diameter. Sigmatocome not found .....*Chaunoplectella spinifera*. (Sagami Sea).
- d*<sup>1</sup>.—The only or the larger kind of discohexaster with convex terminal disc, the margin of which is serrated.
- c*<sup>2</sup>.—With aspidoplumicome. Gastralia hexactinic. Paratangentials of dermalia with curved spines laterally. Body stalked.....  
.....Caulocalyx. —*C. tener*. (W. of Tristan d'Acunha).

- d*<sup>2</sup>.—Without aspidoplumicome. Gastralia pentaactinic. Discohexaster in one kind  
 ..... Placopegma.  
*a*<sup>3</sup>.—Paratangentials of dermalia beset with small erect spines on the outer  
 surface. With sieve-plate and anchoring needles. Discohexaster up to  
 100  $\mu$  in diameter..... *Placopegma solutum*. (B. of Bengal).  
*b*<sup>3</sup>.—Paratangentials of dermalia without spines. Discohexaster spherical,  
 140  $\mu$  in diameter.....  
 ..... *Placopegma* sp., F. E. SCH. '99, p. 44. (SW. of Vancouver Is.).

I now proceed to give full descriptions of the genera and species that occur in the Sagami Sea.

## LEUCOPSACUS\* IJ.

IJIMA, '98, p. 42.

Leucopsacids with small, ovoid or spindle-like body, which may be stalked. Parenchymalia chiefly hexactins; diactinic parenchymalia present, but play a subordinate part. Gastralia represented by hexactins similar to those of the parenchyma. Discohexasters in part hexactinose and in part hexasterous.

## LEUCOPSACUS ORTHODOCUS† IJ.

Pl. III., figs. 14–26.

*Leucopsacus orthodocus*, IJIMA, '98, p. 42.

The species is based on two specimens, obtained by myself at different times at and near Dōketsba from a depth of, say, 214–429 meters (117–235 faths.).

\* λευκός, white; ψαράς, drop.

† ὀρθός, straight; δοκός, beam.

The first specimen (Sci. Coll. Mus., Sp. No. 230) was discovered among the trophies of a long-lining expedition to Dōketsba, which I had undertaken on Aug. 6 th, 1894, together with Professor MITSUKURI. I consider the exact date as not unimportant owing to the fact that the specimen contained larvæ in different stages of development. It was found attached to a dead *Caryophyllia*-like coral in company with a specimen of *Lanuginella pupa*, and is shown in Pl. III, fig. 14, in natural size. The body is of an ovoid shape, with the inferior narrower end continued into a stalk of moderate length. Total height, 11 mm.; greatest breadth, 6.5 mm. The upper rounded end bears, somewhat to one side of the center, a roundish osculum of 1.5 mm. diameter. The stalk is laterally compressed, measuring in breadth 2 mm. in one direction and only 1 mm. in another; it expands at the lower end into a small basal disc. The sponge-wall is about 1.5 mm. thick at the part where the body is broadest; the oscular margin is thin and simple (fig. 15). So far as can be made out by cutting open the wall, the gastral cavity seems to extend downwards for a considerable distance into the stalk.

The second specimen (Sp. No. 438) was obtained also by me, Aug. 12 th, 1895, at a spot in or near Dōketsba but which could not be precisely located on account of the foggy weather. It is a fragment representing the upper part of an individual probably similarly shaped, but somewhat larger than the first specimen. It bears a roundish osculum of 2 mm. diameter. The wall is nearly 2 mm. thick in the thickest part.

In general appearance both specimens remind one of *Lanuginella pupa*, long known from the Atlantic and which also occurs in the Sagami sea. The external surface is perfectly smooth. Examined under a hand-lens the apertures of incurrent canals

appear as indistinct minute spots beneath a thin and clear dermal layer. On the gastral side the excurrent canals open apparently directly into the cavity; many of the openings are considerably larger than the incurrent canalar apertures seen on the outside. The sponge is soft and delicate in texture. In all essential points of the spiculation the two specimens agree closely with each other.

In view of their small size, I at first considered it possible that these were young specimens, but the presence of large archæocyte-congeries in both and the discovery, in one specimen, of larvæ which apparently belonged to it, decidedly support the view that they are mature and full-grown individuals.

### Spiculation.

The *parenchymalia*, forming the main framework of the sponge-wall, are for the most part regular oxyhexactins of moderately large size; diactins occur in a relatively small number. The oxyhexactins have straight tapering rays which may reach nearly half a millimeter in length and  $10\mu$  in thickness close to the central node. There are all sizes leading down to the dimensions, given later, of those oxyhexactins which I consider as gastralia. The rays appear smooth under a low magnification but are in fact insignificantly rough-surfaced on account of minute tubercles occurring at rather wide intervals all over them. The general manner of arrangement of the hexactins in relation to one another is such that, while being disposed in several layers with one axis directed radially, they have each of the rays placed, for



nearly its entire length, side by side with or in more or less close apposition to, a ray of adjacent hexactins (Pl. III, fig. 26). The result is a parenchymal framework which, whether seen in a transverse or a longitudinal section, presents approximately rectangular or quadrate meshes bounded by straight beams; hence the name I have given to the species. The beams consist usually of two, but sometimes of three, spicular rays running alongside but not always placed compactly together. It is however by no means infrequent to find some hexactins, situated in an indefinite relation to their neighbors, thus disturbing the regularity of the framework. This is no doubt due in a measure to the free state of each separate spicule.

The comparatively few diactins that occur as parenchymalia are small forms, probably never more than 1.5 mm. in length and  $8\mu$  in breadth near the center, which is always marked externally by an annular swelling. The surface is smooth, but towards the gradually attenuated ends, is roughened by micro-tubercles sparsely present. More especially are the oxydiactins to be found in the deeper parts of the wall, running either isolatedly or combined in weak bundles.

In the basal disc and directly against the foreign surface to which the sponge is attached, the parenchymal hexactins form a thin, irregularly meshed, *basidictyonal plate*. This is of essentially the same structure and appearance as that I have described from *Regadrella okinoseana* and *komeyamai* (Contrib. I., pp. 231-232, 264). The medium-sized, rough hexactins, which go to compose it by being soldered together either directly ray to ray or by means of irregular synapticulae, may have rays as thick as  $16\mu$ .

The *gastralia* differ in no way from the ordinary parenchymal oxyhexactins in their characters, except in being on the whole smaller and in having proportionally thinner rays. Axial length  $280\mu$  and over. It would not be improper to say that they are here represented simply by those parenchymal oxyhexactins which, being situated in the deepest part of the wall, project one of their rays into the gastral space. They are found rather irregularly scattered and are far from forming a continuous gastral layer.

Like the *gastralia* the *dermalia* are only slightly differentiated from the parenchymal hexactins, except in lacking a distally directed, sixth ray. To be more explicit, the *dermalia* are exclusively moderately large oxypentactins with the rays supplied with sparsely distributed, quite insignificant microtubercles similarly as in parenchymal oxyhexactins. The cruciate paratangentials up to  $270\mu$  in length and  $15\mu$  in breadth near the central node, are in either a perfectly flat or a slightly outwardly curved plane. The straight, unpaired, proximal ray is longer than,—often fully twice as long as,—the paratangential in the same spicule; it generally runs in association with a radially directed beam of the parenchymal framework. Observed from the surface, the centers of the paratangential crosses lie separated from one another by a space nearly equal to, or considerably less than, the length of the paratangentials,—by a distance of about  $200\mu$  on an average. Occasionally there are seen two centers, placed close together. At the same time the paratangentials form the usual, quadrate-meshed, dermal latticework, the beams of which are composed usually of two, but sometimes of one or three, rays running together. As is usual, the dermal meshwork is

by no means everywhere uniformly and regularly developed but shows at places a greater or less deviation from the regular pattern.

The *hexasters* of the species may be said to be of two kinds, *viz.*, the larger hexactinose and the smaller hexasterous discohexasters, both found commonly in the tissues of the choanosome.

The *hexactinose discohexaster* (Pl. III., fig. 16) is essentially similar to that known to occur in the Euplectellid genus *Corbittella* (I., Contrib. II.) or to the spicule figured by F. E. SCHULZE from *Rossella antarctica* (Chall. Rep. Pl. LV., fig. 8) but regarded by him as perhaps extrinsic and intruded. In the present species it measures 110–168  $\mu$  in axial length. The six, slender, smooth and straight arms, arising from the central node in exactly the same way as the rays in a regular hexactin, thicken slightly towards the outer end, which bears a convexly arched, anchor-like umbel of 3–5, usually 4, strong, recurved and sharply pointed teeth. These are, as measured from tip to umbel center, 14  $\mu$  long on an average. Special examination of the spicule mounted in glycerine, showed the central cross of axial filaments in the central node, the filaments not extending themselves beyond the base of each arm, precisely in the manner indicated in fig. 30, Pl. III.

The *hexasterous discohexaster* (Pl. III, figs. 17–20), *i.e.*, the form in which each principal bears more than one terminal in distinction from the hexactinose form, is somewhat variable as regards size and certain other points, not only in different individuals but also in one and the same individual. It may be said in general that the most usual size is 60–75  $\mu$  in diameter. Each short principal is supplied with a bell-shaped, outwardly

expanding tuft of 4-8 (most commonly 7 or 8) terminals, which arise not always in a single circle but sometimes so that one is surrounded by others in a whorl. The terminals are of moderate strength and terminate each with a small star-like disc having 5 or 6, minute, marginal teeth; their surface is obsoletely rough. The general shape of the discohexaster is quite often not unlike that of a floricome.

In one (Sp. No. 438) of the two specimens, on which the species is based, I find the range of variability of the discohexaster in question somewhat wider than in the other. (Pl. III., figs. 18-20). In that specimen there are occasionally some discohexasters that are so small as to measure only  $50\mu$  in diameter, while others not infrequently reach up to  $88\mu$ . The terminals are slightly thinner but often, though not always, more numerous (up to 11 in a tuft) than in the other specimen (Sp. No. 230). By the side of such discohexasters rather copiously supplied with terminals, there exceptionally occur others of a comparatively large size such as is represented in fig. 20, in which each principal is seen to bear only 2 or 3 terminals. No such rosette was found in Sp. No. 230.

### Notes on the Soft Parts and the Larva.

As the specimens were killed and hardened by means of corrosive sublimate, the soft parts are preserved, not so satisfactorily as might be desired, but in a sufficiently good condition to enable me to make the following observations.

As in *Euplectella marshalli* (Contrib. I., p. 123), the dermal

membrane is usually not membranously developed but is represented by fine, irregularly branching and anastomosing, cobweb-like threads spread over the meshwork formed by the paratangentials of the dermalia. The "pores" or the gaps inclosed by the threads are accordingly not rounded and pore-like, but quite irregular in shape and size. The dermal membrane is therefore in no way distinguishable from the more deeply situated trabeculae, with which it is in fact directly continuous.

In the subdermal space, which is nowhere of any great extent, trabeculae are present in moderate abundance. The nuclei, found here and there in the little stained granular substance of the trabeculae, measure not more than  $2\mu$  in diameter. They are moderately strongly colored without showing chromatic contents with any distinctness.

Archæocytes occur in abundance as usual, especially on and close to the outside of the flagellated chambers, either solitarily or grouped together in exceedingly variable number. They are  $2-3\frac{1}{2}\mu$  large. A strongly stained and externally well defined cytoplasm is to be ascribed to the cells, though always sparsely present. The nucleus is of about the same size as the trabecular nucleus, but generally incloses a somewhat refractive chromatic mass; it is about as well stained as the cytoplasm, though appearing clearer at a certain focus of the microscope.

In Sp. No. 230, but not in the other specimen, I have found a number of large, ovum-like cells (dia.  $20-40\mu$ ), apparently freely occurring in the trabecular spaces. A description of these peculiar cells has already been given by me in my Contribution I. (OI), p. 182, and need not be repeated. A figure of one is now given in Pl. III., fig. 21. As to their real nature and import, I am still in the dark.

The flagellated chambers are cup-like or thimble-like. The more elongated chambers occur in the periphery of the choanosome. The flagella are not preserved in my preparations. The chamber-wall consists of the usual *membrana reticularis*, the open meshes of which may measure  $7\frac{1}{2}\mu$  or less across. At places, a pale ill-defined nucleus may be defined tolerably constantly at every nodal point of the reticulum.

**The larva** (Pl. III., figs. 23-25).—As announced in my Contribution I. (pp. 182, 187), *Leucopsacus orthodocus* is one of the two Hexactinellid species in which I have discovered developmental stages of larvæ, or at any rate of certain reproductive bodies which may reasonably be interpreted as such,—the other species being *Vitrollula fertile*, a Rossellid to be described in full in a future Contribution. It was in only Sp. No. 230 of the above mentioned Leucopsacid that I have found the said reproductive bodies. These had to be searched for in sections of the sponge and were by no means so numerous, nor so favorably conditioned for observation, as was desirable; hence, the fragmentary nature of the account given below.

As before indicated, there exist, in both the specimens examined, variously sized archæocyte-congeries (Pl. III., fig. 22) between the chambers or in the narrow spaces between the evaginations of the chamber-layer. To judge from appearances, they grow in size by multiplication of the compactly crowded cells. A large congeries is spherical or approximately so and may be nearly or quite as large as the body, shown in Pl. III., fig. 23 and which I consider as the larva in an early stage of development.

The larva in this stage is spherical, measuring about  $57\mu$  in



diameter. It shows a moderately thick epithelial covering, in which the nuclei are indistinctly visible but the cell-outlines scarcely visible at all, owing in a great measure to the diffuse and strong staining of the cells as well as to the thickness of the preparations. However, to judge from the arrangement of the nuclei, we here evidently have to do with a single-layered cylindrical epithelium. The epithelium appears on the whole somewhat clearer than the internal cell-mass from which it seems to be distinctly delimited. Whether it extends over all the surface in equal thickness or distinctness could not be determined with certainty. Often in one and the same larva it can not in fact be perceived with as much distinctness in one part as in another; this may be due as well as not to certain defects in the manner of preparation. Frequently, but not always, a clear, irregularly granular layer is seen to cover the external surface. I consider that layer to have been brought about by the deterioration of the flagella belonging to the epithelial cells, as the result of the hardening process.—The internal mass is diffusely and very strongly colored; it shows closely crowded nuclei, around which cell-outlines can not be defined with any degree of distinctness. A further insight into the histology could not be obtained, all my sections being much too thick for that. Under a moderately high power of magnification, the internal cell-mass appears densely and uniformly granular, exactly agreeing in all points with a larger archæocyte-congeries. From the latter, it may be said, the larva in the early stage now being described differs only in the presence of the peripheral epithelial layer. And there exists nothing besides such archæocyte-congeries to which the origin of the developing larva can be traced back with any degree of probability. For the enigma which follows this

way of interpreting the source of the larva, the reader is referred to my enunciations in my Contribution I., pp. 185-190.

By the time the larve has grown to a size of 60-70  $\mu$  diameter, the first spicules make their appearance (Pl. III., fig. 24). These are minute and delicate-rayed oxystauractins,—not hexactins, contrary to what might be expected on *a priori* grounds. It does not necessarily follow from this that stauractins represent the most primitive form of Hexactinellid spicules. I simply consider that the stauractinic form of the spicules developing first in the ontogeny is due to the suppression of one of the three primitively present axes, in adaptation to a certain secondary condition of the larva—assumably to circumstances of the space in which the spicules develop themselves, as seems to hold true in a general way of all triaxonic spicules with a reduced number of rays. A close investigation of the central cross of the axial filaments—which however can not be undertaken with the objects in hand—will presumably reveal an abortive third filament representing the suppressed axis.

The said embryonal oxystauractins are situated in the periphery of the central cell-mass, with the plane of the four rays disposed paratangentially to the surface of the larva; they lie not in direct contact with the external epithelium but well separated from its internal limit by a few cells of the internal mass. To give a connected account of what I have seen in several larvæ, the oxystauractins are at first scattered singly; they are by no means numerous in number and show no definite rule as to the manner of relative distribution, except in that they always occur in a single layer. They grow in size, apparently without increasing in number; all seem to have taken origin nearly simultaneously and are therefore of approximately the same size. They soon

come to intersect one another with their elongated rays. After reaching a certain size, each single oxystauractin is distinctly outwardly convex, in conformity with the rounded external surface of the larva. The convexity becomes more and more pronounced as the spicule grows larger, which takes place with comparatively greater rapidity than the growth of the larva in general size. The entire skeleton, considered apart from the soft parts, represent a hollow spherical basketwork composed of the loose oxystauractins. (In figs. 24 and 25, Pl. III., the soft parts are drawn as seen in optical sections, while the spicules put in are all those that could be seen in one-half of the larva by focussing the microscope up and down).

In the stage shown in fig. 24, Pl. III., in which the approximately spherical body measures about  $70\mu$  in diameter and the spicules reach up to  $30\mu$  or thereabout in axial length, the soft parts still appear to retain the same histological character as before the formation of spicules. At places favorably situated for the observation, there is to be seen on the surface a granular coating, indicating the presence of flagella to the external epithelial layer.

Further advanced stages than those just referred to were not discovered except in a single case, which is shown in fig. 25. In this larva, the body, still approximately spherical in shape, may measure nearly  $100\mu$  in diameter. An exact measurement can not be made since the larva lies so mixed up in the soft tissues of the choanosome that it is difficult to precisely determine its external limit. The epithelial covering, which should not be wanting until after the larva should have fixed itself on a foreign object after liberation from the mother body, is entirely concealed from view. Most plainly visible is the hollow skeletal basketwork.

The oxystauractins composing this have now greatly grown in dimensions; their smooth, gradually tapering rays may be  $57\ \mu$  long. All that I can say concerning the soft parts is that the cells (or nuclei) within the hollow of the skeletal system are now arranged, not compactly crowded as before, but in irregularly reticular tracts, evidently on account of the formation of vacant sinus-like spaces.

The above account of the larval development, incomplete as it is, will be corroborated and in a measure also supplemented by the description, to be given in another place, of the same process in *Vitrollula fertile*.

### LEUCOPSACUS SCOLIODOCUS\* IJ.

Pl. III., fig. 27-37.

*Leucopsacus scoliodocus*, IJIMA, '98, p. 43.

This species is now known to me in more than a dozen specimens, all from the Sagami Sea and a depth of 400 hiro (313 fms.=572 m.) or thereabout. They represent fusiform, ovoid or globular, moderately thick-walled sacs, up to the size of a small acorn or a hazel-nut. The particulars about the specimens are as follows:

Specimen No. 233 of the Sci. Coll. Mus. (the largest of the three shown in Pl. III., fig. 27) is globular but somewhat laterally compressed. Height 17 mm.; breadth in the middle 10-13 mm.; wall 4 mm. thick in the thickest part. The constricted

\* σκολιός, curved; δοξός, beam.

base is  $6\frac{1}{2}$  mm. broad. This expands below into a firm, thick, basal disc, 11 mm. in diameter. The osculum at the upper end is roundish, measuring 5 mm. in diameter and with a thin and simple oscular margin. The specimen was found attached on an undescribed *Hexactinella*, which shall be described in a later Contribution under the name of *H. lorica*. Locality: Outside Okinosé by Iwado-line.

A bottle, numbered 235 in the Sci. Coll. Mus., contains no less than nine specimens of the present species from the same locality, all found attached likewise to a piece of *Hexactinella lorica*. Two of them are shown in natural size right and left of fig. 27, Pl. III. All the specimens are small, being fusiform or ovoid in shape and round in cross-section. The smallest is not larger than a grain of rice, while the largest is 13 mm. long and 6 mm. broad in the middle. The upper end is occupied by a round and simple osculum; the opposite end terminates in a firm basidietyonal mass or plate, which may be very thin or of a considerable thickness. Fig. 28, Pl. III., represents the appearance of one of the specimens as seen in a stained longitudinal section.

On still another *Hexactinella lorica* (Sp. No. 448) from the same spot and a depth of 572 m., I have found several *L. scoliodocus* of varying sizes (2-13 mm. in height), in company with *Lanuginella pupa*, *Staurocalyptus pleorhaphides*, etc.

Finally I have to mention a specimen from the northern side of Onigasé (Sp. No. 434). It has the shape of a somewhat laterally compressed spindle, 20 mm. long and 11 m. broad in the midde, in which region the wall is about 2 mm. thick. The truncated oscular end as well as the base measures about 4 mm. in breadth.

The dermal surface in all the specimens is smooth. In the profile edge of the body, there is seen a clear space right under the dermal layer and separating this from the opaque choanosome; it is the relatively widely developed subdermal space. The surface of the choanosome presents a spongy appearance on account of the ill-defined, variously sized but on the whole small, apertures to incurrent canals. The gastral surface is not covered with a continuous gastral layer, but there directly open excurrent canals which may measure 1 mm. or more across in the larger specimens. Such a small specimen as is represented on the right of fig. 27 may, in the wet state, be said to be nearly translucent all over excepting only the basidictyonal mass which appears whitish.

None of my specimens is in a sufficiently good state of preservation for a histological study. Nevertheless, thus much could be determined, *viz.*, that the trabeculae are scantily and thinly developed both in and below the bounding surfaces, and that the shape and arrangement of the chambers are much the same as in *L. orthodocus*.

### Spiculation.

The *parenchymalia* consist of oxyhexactins and diactins, the latter occurring only very sparsely (Pl. III., fig. 37).

The parenchymal oxyhexactins may be said to be of a moderately large size, though subject to much variation in this respect. A large one may measure 4 mm. or more in axial length and about 13  $\mu$  in breadth of ray near the central node; but such large dimensions are attained by the spicule in question.



only in the larger specimens of the species. The larger parenchymal oxyhexactins lead over by forms of intermediate sizes to the small and slender-rayed gastral oxyhexactins, which measure generally only 260–340  $\mu$  in axial length. The rays gradually attenuate outwards and are usually smooth except near the finely pointed ends which are more or less rough-surfaced. Only the smaller oxyhexactins, notably those which I consider to be gastralia, have rays rough all over on account of very minute and sparsely scattered tubercles. Both the parenchymal and the gastral oxyhexactins in the present species are characterized by the fact that the rays are seldom straight but far more usually curved to a greater or less degree—sometimes gently and at other times in an arch-like or a wavy manner—apparently in no definite plane or direction. Accordingly, when they combine to form a bundle, as they sometimes do, this takes an irregular sinuous course; hence the name I have given to the species. In this respect the species is at once distinguishable from *L. orthodocus* in which the parenchymal hexactins have straight rays and give rise to a skeletal framework with rectangular meshes.

The parenchymal diactins are present in such a small number that in many slide-preparations of the wall they have to be specially searched for. However, they are to be constantly found in tolerable abundance, either isolatedly or in bundles, in the basal region of the body, where they pass out from among the basidictyonal mass and upwards into the body-wall. In size and characters the diactins agree with those of *L. orthodocus*.

The *dermal skeleton* again is very similar to that of the species just referred to. It consists exclusively of moderately large oxypentactins, amongst which none can be distinguished as

hypodermalia; they are themselves but little specialized from the parenchymal oxyhexactins. It may be said in general that in length of rays they are about equal to the larger oxyhexactins of the parenchyma in the same individual. In most of the different individuals examined, I have found the length of the cruciately disposed paratangential axis to fluctuate between  $500\ \mu$  and  $800\ \mu$ ; in the large specimen (No. 434) from Onigasé, the same axis reaches up to  $1\frac{1}{2}$  mm. in length and  $20\ \mu$  in breadth of ray near the central node. The unpaired proximal ray is always longer than, and often fully twice as long as, the paratangential of the same spicule; it is always straight and dips inwards, generally in association with the radially directed axis of a parenchymal oxyhexactin. The paratangentials, as seen in surface view, are straight; the latticework formed by them is on the whole irregular, though in places an approach is shown to the formation of rectangular meshes. In lateral views the paratangentials are either likewise straight or so curved as to accommodate themselves to the curvature of the external body-surface. As in parenchymal oxyhexactins, the rays taper towards their ends, near which the otherwise smooth surface is more or less roughened by the presence of obsolete microtubercles.

The *gastral oxyhexactins*, already described in passing, occur in abundance on the internal surface, without however showing any definite order in their relations with one another or forming a distinct layer by themselves. Exactly similar oxyhexactins often occur also as *canalaria* along the lumen of excurrent canals.

The *basidictyonal plate* or *mass* is composed, as usual, of synapticularly fused, thick-rayed hexactins, the rays of which are

beset with prickles on the surface. The hexactins may be so large as to measure  $120\ \mu$  in axial length and  $10\ \mu$  in thickness of rays. At places the prickles on the basidictyonal beams are elongated into stout, sharply pointed spines, as much as  $30\ \mu$  in length.

As constant *hexasters* of the species are to be mentioned discohexasters of both the hexactinose and the hexasterous varieties.

The *hexactinose discohexasters* (Pl. III., figs. 29 and 30) are shaped exactly like those of *L. orthodocus*. They are of common occurrence everywhere in the body-wall; only in the specimen (No. 434) from Onigasé were they found scantily represented. Axial length,  $100\text{--}180\ \mu$ . Number of terminal anchor-teeth, usually 3 or 4, sometimes 5, in a whorl. The limited extent of axial threads in the spicule, as ascertained by special examination, is depicted in fig. 30.

Of the *hexasterous discohexasters*, the most constant are the forms shown in Pl. III., figs. 32–34. These are especially abundantly met with in the periphery of the wall. In diameter they commonly measure  $70\ \mu$ , though sometimes only as much as  $46\ \mu$ . In the larger discohexaster each very short principal usually bears 8 or more, rough-surfaced, moderately strong-looking terminals, while in the smaller one there may be only 4 terminals to a principal. The small, convex, terminal disc is provided with 5 or more, minute, marginal teeth. The terminals from all the six principals radiate in such a way that the terminal discs are all situated nearly equidistant from one another, the result being the spherical shape of the entire spicule. Here I see another point of difference from *L. orthodocus*, in which the corresponding discohexaster has the terminals arising from each principal arranged in a separate perianth-like tuft.—As variations

of the discohexaster under consideration are found occasionally such forms as resemble the two shown in figs. 35 and 36, Pl. III. They grade over to the more usual spherical discohexasters through intermediate forms. Those, of which the one figured in fig. 35 may be taken as a representative, are unusually large (up to  $114\mu$  diameter) and have long, slender terminals, 7 or 8 in number to each principal. Spicules like fig. 36 are more rarely seen; in these, each principal possesses usually three somewhat bent terminals, the discs of which have marginal teeth appreciably larger than usual.

Of inconstant occurrence in the species is the small and delicate form of hexasters, represented in fig. 31, Pl. III. We have here to deal with a rosette which is very much like a floricome in appearance but differs from it in the fact that the terminals end in insignificant pinhead-like knobs, instead of toothed plates. For the sake of reference we may call it a *tylfloricome*. Diameter 38–50  $\mu$ . Principal slender; in length about  $\frac{1}{4}$  that of the entire ray, or shorter. Terminals very fine, slightly thickened towards the outer knobbed end; 7–10 in a whorl to each perianth, which is narrow but outflaring at the outer end. I first became aware of the presence of the tylfloricomes in the specimen (No. 434) from Onigasé, in which they are tolerably common, especially near the gastral surface. Not infrequently a tylfloricome is found shifted right to, and hanging on, the tip of the freely projecting ray of a gastralium, after the manner of floricomes on Euplectellid dermalia. A subsequent search in the Okinosé specimens revealed the occurrence of the same hexaster, though never more than sparsely, while in some cases it was entirely absent.

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## CHAUNOPLECTELLA \* IJ.

IJIMA, '96, p. 250 ; '98, p. 43.

Leucopsacids with moderately large, ovoid or vase-like and thick-walled body, attached by short stalk-like base. Parenchymalia chiefly hexactins and diactins. Dermalia either all pentactinic or with a variable number of rays, none of which however are distally outstanding. Gastralial represented by hexactins similar to those of the parenchyma. Discolhexasters always hexasterous, the larger ones with terminal prongs arranged in a whorl like anchor-teeth ; with or without sigmatocome in addition.

## CHAUNOPLECTELLA CAVERNOSA IJ.

Pl. IV., and Pl. V., figs. 8-13.

*Chaunoplectella cavernosa*, IJIMA, '96, p. 250 ; '98, p. 43.

Since my first description of this species which was based in 1896 on a single fragmentary specimen, I have had opportunities to examine nearly a dozen specimens of various sizes, all preserved complete in the dried state. They all came from the Sagami Sea, though in only two cases can the collecting ground be more exactly specified ; *viz.*, the vicinity of Okinosé in one case, and Maye-no-Yodomi, 572 m. (313 faths.), in the other.

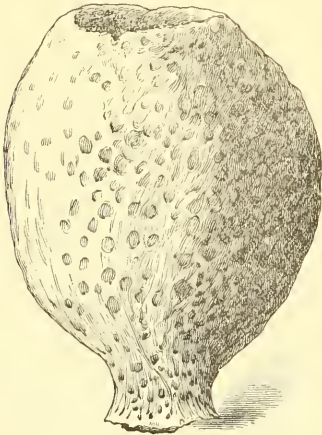
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\* χαλκός, loose ; πλεκτός, interwoven.



In general the sponge is ovoid and goblet-like or more elongate and vase-like. Total height, up to 200 mm. or more. Inferiorly it is attached to the hard substratum by a short, thick, stalk-like base. The wall is thick and consists of remarkably loosely interwoven tissues. It presents quite a cavernous appearance on account of the wide spaces within it. Hence the generic and specific name I have chosen for the sponge.

To make special mention of a few specimens, the one shown in Pl. IV., fig. 1, reduced to one-third the natural size, is the fragment (Sci. Coll. Mus. No. 443) from which I originally described the species. It is a part of a large individual, with the wall as thick as 52 mm. and measuring not less than 160 mm. in diameter of body as judged from the curvature of the external surface. The piece includes a portion of the stalk-like base. In general shape the entire individual must have closely resembled the one shown in the woodcut given below.



A complete specimen *Chaunoplectella cavernosa* (O. C. No. 106). Reduced to  $\frac{1}{3}$  natural size.

This complete and beautifully preserved specimen belonged to Mr. Alan Owston (O. C.\* No. 106). Total height, 185 mm. Diameter in the middle of body, 126 mm. Wall in the middle, 30–44 mm. thick. The osculum at the upper end was oval, measuring 47 mm. by 63 mm. in diameter; the margin was thick and

\* O. C. stands for Owston Collection.



rather obtusely edged, without fringing spicules. The gastral cavity was tubular, 165 mm. deep and somewhat narrowed at the bottom. The attachment-surface of the base was covered over with a compact basidictyonal plate, 2 mm. thick, from which the loose parenchymal spicules could be easily separated without injuring their ends.

Another ovoid and complete specimen I examined was 190 mm. high and 15 mm. broad. It was attached to a smooth loose stone.

Some specimens show a more elongate and vase-like shape; they may be cylindrical or more or less laterally compressed. Further, the basal end may sometimes be bent, probably as the result of the sponge happening to grow upon a perpendicular surface.—The tallest specimen I have seen was an erect, laterally compressed, vasiform individual, 200 mm. high. Another elongate but cylindrical specimen (190 mm. long) was remarkable for the fact that it grew with a bent base upon a piece of porcelain ware, a part of an old-fashioned Japanese oil-burner, that had probably been dropped from a sea-faring junk.

Pl. V., fig. 10, represents in half natural size a strongly laterally compressed, pouch-like specimen, exceptionally well preserved as to the delicate spicular texture. It belonged to Mr. Alan Owston (O. C. No. 4386). Height, 156 mm. Breadth, 125 mm. on one side and 65 mm. on the other. Wall, 30 mm. thick in the thickest part. Osculum, irregularly oval, 60 mm. in longest diameter; its margin, sharp but not thin. The stalk-like base is bent towards one side; this bending, it will be noticed, is in the sagittal plane of the compressed body, which fact is the rule with all lyssacine Hexactinellids having a laterally compressed body and bent base.

Here I must turn to a consideration of certain small and young specimens which seem to offer some points of interest. On that most remarkable skeleton of a dead *Chonelasma calyx*, which I have had occasion to mention and figure in Contribution I. of this series of studies (Ij., '01, pp. 25, 31), I have found, amongst the host of other animals attached to it, five young of the present species in different stages of growth (Sci. Coll. Mus. No. 407). Four of these are shown in Pl. V., figs. 8 and 9, in natural size. The three specimens to be seen in the latter figure are all globular in shape, each with a small roundish osculum at the upper end. The smallest of the lot measures only 3 mm. in body-diameter. They all sit together on a common, compact, basidietyonal plate of irregular outline and disproportionally large size. The undulating surface of the plate is finely granulated and shows some furrows in it; below, its substance permeates the underlying *Chonelasma* skeleton to a depth of 2 mm. or more. There can be no doubt whatever that the plate in question belongs to, and is the product of, the little sponges growing on it.—The fourth specimen, which is not figured, is of an elongate ovoid shape, 9 mm. in length; the base, only 2 mm. thick, stands out from the center of an irregularly expanded basidietyonal disc of about 9 mm. diameter.—The fifth and largest specimen is the one shown in fig. 8. It has the form of a thick-walled cup, 31 mm. high. The broad base joins the basidietyonal plate—which clasps a parietal process of the *Chonelasma* and at one place stretches out fully 10 mm. beyond the apparent basal edge of the body proper—making a distinct line of demarcation, which is due to the circumstance that here the loose tissue of the sponge-wall passes abruptly into the rigid reticulum of the plate.—The relatively large size of the basidietyonal plate in the above specimens

leads one to the supposition that its growth takes place with considerable—so to say, precocious—activity in the early period of post-larval life. Later, the rate of its growth seems to more closely coincide with that of the body, so that the early ratio in size of the two parts is not maintained in after-life.

The external surface of the sponge is rather uneven. The dermal layer covering it is of a somewhat unusual spicular composition. As seen under a hand-lens, it consists of irregularly interlaced beams, running in quite indefinite directions in the plane of the surface (Pl. IV., fig. 7). The beams, though thin on the whole, are of various degrees of strength, the strongest being as much as  $\frac{1}{2}$  mm. in thickness. The thinnest beam consists of no more than a single spicular ray, while others are made up of a varying number of rays grouped together into a more or less compact-looking bundle. Not infrequently, a beam, springing out from another as a branch, is seen to terminate freely, without reaching up to that towards which it is directed. Altogether the dermal latticework is irregular. The meshes often have sides of 1 mm. and more in length, and must be said to be on the whole coarse, besides being irregular in shape.—The meshes are covered with a sieve-like dermal membrane, made up of membranously flattened trabeculae around and between the closely disposed, roundish pores (Pl. IV., fig. 7).

The want of regularity in the arrangement of dermal spicules and the coarseness of the meshes serve as a convenient mark of distinction between this species and certain Rossellids of a bewilderingly similar external appearance, e. g., *Staurocalyptus glaber* Jr.

On the surface of the stalk-like base, the dermal layer is

usually wanting, thus directly exposing the thick, wavy, soft and silky bundles of the parenchymalia.

An unusually wide subdermal space separates the dermal layer from the choanosome (see Pl. IV., fig. 4). In the larger specimens it may in places be nearly 10 mm. wide. Pillars of conical or irregular shape project from the choanosomal surface at intervals of 5–12 mm. or more; these divide at the apex into a number of fibrous bundles which go to join those of the dermal layer.

The oval or round entrances into the incurrent canals are more or less conspicuously visible through the dermal layer. They are on the whole very large, though by no means uniform in this respect, either in the same specimen or in differently sized individuals. In the specimen of fig. 1, Pl. IV., some of the incurrent canalar openings have a width of 15 mm. or even more; in that shown in the woodcut on p. 54, the largest opening measured 10 mm. across.

In all large specimens there exists a continuous gastral layer, covering up the wide apertures of the excurrent canals. This is of much the same irregularly reticular appearance as the dermal layer; only it may be said that in general the meshes are somewhat wider, while the intersecting points of the beams strike the eye as small whitish knots due to accumulations of certain discohexasters. In the interapertural spaces the layer lies closely over, and is often indistinguishable from, the parenchymal tissues. In the medium-sized specimen of fig. 10, Pl. V., the gastral layer leaves a few of the excurrent apertures uncovered, seemingly not as a result of artificial disturbance. In small specimens, such as are depicted in figs. 8 and 9, Pl. V., all the excurrent canals open directly into the gastral cavity. The gastral layer then

appears to be a structure which begins to be formed at a comparatively late stage of life.

The excurrent canalar apertures as compared with the incurrent, are on the whole somewhat larger but less numerous. This is evidently in correlation with the difference in extent between the inner and the outer choanosomal surfaces respectively occupied by the two sorts of apertures. The fact just mentioned may be laid down as a rule holding good for a large number of Hexactinellids of similar shape.

The fineness of all the spicules, the wide subdermal space and the broad canals—both incurrent and excurrent—separated by thin septal walls, all combine to give to the sponge a light, delicate and cavernous character, which is especially pronounced in specimens of larger size (fig. 4, Pl. IV).

### Spiculation.

The following account of the spiculation refers, unless otherwise stated, to large and full-grown individuals as represented chiefly by the fragment shown in Pl. IV., fig. 1. It may be regarded as holding good also for young specimens, but these are not without noteworthy points of difference, of which special mention is required.

The *parenchymalia* are, it may be said, mainly hexactins and diactins, although those with 3-5 rays are not uncommon. They are also very variable in dimensions. The rays are smooth, gradually tapering and terminate either simply pointed or with a

slight subterminal swelling. The surface for a short distance from the end is always roughened by the presence of microtubercles.

A parenchymal hexactin may attain a considerable size. One of the largest I have picked out from a large specimen had rays as long as 7 mm. and  $70\mu$  thick near the central node. But the majority are much smaller and more slender-rayed, leading down to such oxyhexactins as will later be described as the canalaria (Pl. IV., fig. 8; Pl. V., fig. 12). The hexactins, when of a small size, present a regular or nearly regular appearance, but are otherwise more or less irregular, not only in that the rays are bent—sometimes strongly bent—but often also in having rays of unequal lengths (Pl. IV., fig. 6). This inequality may be sufficient to give a stump-like appearance to some rays in comparison with the others in the same spicule. It even leads over to cases in which one or more rays are reduced to total atrophy; so that, besides the hexactins and diactins there are to be met with among the parenchymalia such intermediate forms as are to be called pentactins, tetractins and triactins (Pl. IV., fig. 5, *b-d*; Pl. V., fig. 12). The tetractins are represented either by stauractins or by those formed by suppression of two rays belonging to different axes. The triactins are usually tauactins, seldom the other form composed of rays representing three half-axes.—The abortive development as well as the crooked state of the rays in many of the above parenchymalia evidently stands in relation to the thinness of the choanosomal septa, which ill affords sufficient space for their free and natural development. Nevertheless, parenchymalia are occasionally found which project one or more of the rays beyond the septal surface and freely into canalar lumen. For instance, in fig. 12, Pl. V., which represents the



spiculation of the septal wall as seen in a section, a parenchymal tauactin is seen to send out beyond the surface its short unpaired ray, which, like the outstanding rays of canalicular oxyhexactins, is supplied with a sigmatocome at the tip.

In small specimens of the species, such as are shown in fig. 9, Pl. V., all the parenchymal hexactins, which are certainly never so large as in full-grown individuals, are nearly regular in form. In most of them the rays are almost straight or but little bent, and do not show striking differences in their length. Spicules with 3-5 rays are not present or are, at any rate, quite scarce, so that the parenchymalia may be said to consist largely at least, if not entirely, of hexactins and diactins.

The parenchymal diactins are represented by all sizes, from those of the dimensions of ordinary comitalia up to those with a length of 12 mm. and a breadth of  $50\mu$  in the middle. But the thickness never reaches the degree attained by the rays in some hexactins. The center is sometimes externally marked by an annular swelling, but more generally it is not. The diactins are disposed either more or less isolatedly or in bundles, generally in company with other kinds of parenchymal spicules. They are relatively few in number in the main body of the sponge, where by far the greater part of the parenchymalia consist of spicules with more than two rays. The relative proportion becomes however gradually reversed in the lower region of the body. Here, but more especially in the stalk-like base, the parenchymal fibers form anastomosing bundles of very considerable thickness and of exquisitely silky appearance (see Pl. V., fig. 10). The elements of these bundles are preponderatingly diactins, interspersed amongst which are found small slender-rayed hexactins. The diactins at the inferior end of the bundles are inserted

into the interstices of the basidictyonal plate, without becoming soldered to the latter.

The *basidictyonalia* (Pl. V., fig. 13) form a dense, irregularly meshed reticulum of beams, the surface of which is thickly beset with sharply pointed conical spines. The beams may be  $40\mu$  thick; the spines, as long as  $15\mu$ . Notwithstanding the irregularity in the arrangement of the beams, it is not difficult to make out that these are fundamentally nothing else than synapticularly fused rays of hexactins and sometimes of pentactins also. The rays in these basidictyonal spicules do not exceed  $135\mu$  in length. Sometimes small, thick-rayed and nearly or quite smooth-surfaced hexactins are met with, lying free in close proximity to the spiny beams. They seem to represent early stages in the formation of basidictyonalia, before the soldering together has set in. This takes place wherever the spicules come in contact with one another. The spiny processes on a beam may grow so as to touch and fuse with another beam lying close by, thus transforming themselves into synapticulæ. (In fig. 13, Pl. V., is seen a spiny siliceous ring standing in connection with basidictyonal beams. This is an accidental formation, without doubt due to the same siliceous secretion, as that which is added to the surface of the beams, having taken place around some round object which no longer remains in the preparation).

As regards the *dermalia*, it would be well to mention first those of quite young specimens (Pl. V., fig. 9). In these, they are nearly all, if not exclusively, pentactins of approximately the same ray-length as an average-sized parenchymal hexactin in the same individual. The unpaired ray is of course directed proximad.

The paratangentials are nearly straight; sometimes they are seen to exhibit an uneven surface throughout their entire length, due to the presence of obsolete warty prominences. Thus, in its composition and in the arrangement of the elements, the dermal layer is here essentially the same as I know it in *Leucopsacus* or in *Chaunoplectella spinifera*.

But a very remarkable difference in the spicular composition of the dermal layer is presented by large individuals. With the growth of the sponge, it seems the dermalia are constantly supplemented by spicules genetically belonging to parts directly underlying the dermal membrane. In other words, a large number of peripherally situated parenchymalia are apparently taken up, as it were, into the constituency of the dermal skeleton. The process seems to be not without analogy in other Hexactinellids. Thus, in some Euplectellids certain hexactinic spicules, which have taken their origin right among the parenchymalia, show indications of being shifted on to the surface, to be taken into the rank of the dermalia (Contrib. I., pp. 47, 74, 235); further, the so-called hypodermalia are in all cases spicules which are apparently most nearly related to parenchymalia but have gone by adaptation into the support of the dermal layer. But it must not be supposed from this that certain spicules in the dermal skeleton of mature *Chaunoplectella cavernosa* are to be regarded as hypodermalia and the rest, as dermalia proper. The fact is, at any rate, that none of the dermalia in any stage of the sponge's growth can be distinguished as hypodermalia, a point common to all the Leucopsacids as well as to the Euplectellids in general.

In surface-view preparations of the dermal layer taken from large specimens (Pl. IV., fig. 7), the spiculation resembles in a measure the parenchymalia as seen in choanosomal septa. This

means about the same as to say that the dermalia are but slightly differentiated from the parenchymalia. Like these they are on the whole large, or moderately large; quite variable in the number of rays; and often irregular in shape, not only in having rays of different lengths in the same spicule but also in that these are more or less bent. A large dermalia may show dimensions nearly equal to those of the largest parenchymalia. As regards the number of rays, which in character quite agree with those of the parenchymalia, the dermalia are commonly pentactinic, tetractinic or triactinic, and sometimes even hexactinic or diactinic.

Hexactinic dermalia are generally so situated that the central node lies a short distance below the dermal surface. Four of the rays, representing two axes, run paratangentially and usually associate, soon after their origin from the central node, with other dermalia to form bundles of varying strength. A fifth ray is directed proximad, while the opposite distal ray is either so short that it never projects beyond the dermal surface or is otherwise so bent as to pursue a paratangential course in the dermal layer. Such hexactinic forms occur only occasionally; they are of interest as occupying a position which may be said to be still partly parenchymal.—Pentactinic dermalia usually have the four cruciate rays disposed paratangentially, the fifth unpaired ray dipping inwards into the pillars. Occasionally the spicule may be so unnaturally flattened by the bending of its rays that all five are taken up into the dermal layer, the surface of which is thereby made more or less uneven.—When tetractinic, the dermalia are either stauractins or of the form which shows one complete axis and two half-axes. The stauractins generally lie in the plane of the layer with all the four rays. In the case of the other form of tetractins, either one of the unpaired rays may be directed

proximad and the rest run paratangentially, or all the four rays alike may support the dermal membrane in that the two unpaired rays are forced apart from each other so as to form an angle of more than  $90^\circ$  between them.—Triactinic dermalia are most generally in the form of tauactins. Seldom was the form represented by three half-axes met with. Except that a ray is never directed distad, the triactins may lie in all sorts of positions as regards the directions of the rays.—Diacctic elements of the dermal spicules are of the uniaxial form. They are always slender and comitalia-like, occurring but occasionally as components of spicular bundles in the dermal layer.—Altogether the dermalia are irregular in shape and the latticework formed by them is likewise irregular in appearance.

The *gastral layer* closely resembles the dermal in its spicular structure, except in the fact that hexactins with a freely projecting proximal ray are here of somewhat common occurrence. In the smaller specimens of the species, the hexactinic gastralia are below the medium size and have all the rays nearly equally long; they are comparable in all respects to the canalar oxyhexactins soon to be described. In the larger individuals, the same spicules are much larger, being about as large as the dermalia in the same specimen, and have rays of unequal length. The free proximal ray is always much shorter than most others in the same spicule.

Oxyhexactinic *canalaria* of rather small size line the walls of both incurrent and excurrent canals in irregular distribution (Pl. IV., fig. 8; Pl. V., fig. 12). They are nearly regular in shape and measure  $200\mu$  and upward (mostly about  $500\mu$ ) in



axial length. Rays thin, smooth throughout, gradually attenuating, nearly straight or slightly bent. One of the rays always stands out freely from the septal surface, and where the septum is not sufficiently thick to inclose the entire length of the opposite ray, this may also project from its other surface to a greater or less extent. As before indicated, a sharp distinction can not be drawn between the canalaria and the hexactinic parenchymalia.

The *hexasters* are, broadly speaking, of two kinds, *viz.*, *discohexasters* and *sigmatocomes*.

The *discohexasters* occur in abundance everywhere in the body except in the dermal layer. Of them I may distinguish three varieties or forms which I shall designate with the letters *a*, *b* and *c*. All these merge into one another through forms of intermediate shapes and sizes. They occur in different quantitative proportions and also show certain differences in the manner of relative distribution in the body, according to the size of the sponge. As will directly be more fully pointed out, the three forms seem to represent in a great measure different developmental stages of one and the same kind of *discohexaster*,—stages passed through by it during the post-larval growth of the sponge. Hence it may happen that a quite young sponge lacks *discohexasters* in the older phase of their development, and that a mature one, on the other hand, is either wanting in those representing their younger phase or shows these in but a limited number; whereas, all the developmental phases are numerous and constantly met with in individuals of certain intermediate ages.

Form *a*, to begin with that *discohexaster*-phase which seems to represent the earliest stage of development, comprises the smallest *discohexasters* of the species. Diameter, commonly 100–



120  $\mu$ , but may lead down to 50  $\mu$ . In general appearance the discohexaster is very much like those I have figured from *Lanuginella pupa* in Pl. V., figs. 1, 2 and 4-6, or from *Chaunoplectella spinifera* in Pl. V., figs. 15 and 16. In fact the two last mentioned figures may just as well be considered as representing the discohexaster-form in question from *Ch. cavernosa*. From the end of each very short principal there arise three or four, obsoletely tubercled or nearly smooth terminals, which are each capped with a small convex terminal disc, provided with 7-9, minute marginal teeth. The terminals to each principal diverge in such a manner that they do not form a separate bunch but give to the entire rosette an approximately spherical shape.—The form occurs numerously in all parts of the body in the three small specimens (under 11 mm. height) shown in Pl. V., fig. 9. It is somewhat more scarce in the nut-sized specimen (31 mm. high) of Pl. V., fig. 8, though quite common in the meshes of its basidictyonal plate. In three much larger specimens (above 156 mm. in height) specially examined in respect of the quantitative proportion of different rosettes, the form *a* was found missing, or at any rate exceedingly rare in the sponge-body proper, though still commonly present in the basidictyonal plate remaining on one (O. C. No. 106) of the said specimens.

Form *b* represents intermediate phases between forms *a* and *c*. It is larger than form *a*, measuring on an average, say, 200  $\mu$  in diameter. In general appearance it is quite like the rosette I have figured in fig. 14, Pl. V., from *Chaunoplectella spinifera*. From the swollen end of each stout but very short principal, there arise 2-4, long, slender and obsoletely rough or nearly smooth terminals, which so<sup>2</sup><sub>2</sub> diverge as to give a spherical shape to the entire spicule. The terminal disc, it may be said, is made

up of 4-8, radially arranged, recurved teeth, which give a watchglass-like or hemispherical outline to the disc.—The form in question occurs sparsely in the small specimens of Pl. V., fig. 9. It is common in the nut-sized specimen of Pl. V., fig. 8, while in still larger specimens it is either scarce again or is not found at all.

Form *c* is the most characteristic and the most constant of the discohexasters in specimens of the species that have attained a growth beyond the nut-size. A good idea of its appearance may be obtained from Pl. IV., fig. 9. It is of a very large size, though subject to a considerable variation in this respect like the other forms of discohexasters. It commonly measures 240-340  $\mu$  in diameter; in the larger specimens of the species it may sometimes be even so large as to measure 400  $\mu$  in diameter. The short principals are usually, though not always, so thickened that each presents a rounded knob-like appearance. The long and slender terminals, 2-4 (usually 3) in number to each principal, are strongly divergent and not always straight in their course. They are smooth and perceptibly thickened towards both ends but somewhat more towards the outer end, which bears a reverted umbel of 4-6, long, anchor-arm-like prongs. This terminal umbel gives to the hexaster a very striking appearance. The cupola of the umbel is rounded. The sharply pointed prongs may be 30  $\mu$  long; unlike those in a codonhexaster, they are often more or less bent in an irregular way and proceed divergently backwards from the cupola, so that the umbel assumes the form of a bell with a flaring rim.—The above discohexaster-form undoubtedly represents the most advanced stage of development undergone by the discohexasters of the species. It is still undeveloped in the three smallest specimens depicted in Pl. V., fig. 9. With tolerable

frequency it occurs in the nut-sized individual of fig. 8 in the same plate. And in all still larger specimens it occurs very commonly. In fact, it is at least the predominant, if not the only, discohexaster-form to be seen in the parenchyma of all full-grown specimens. It is usually most abundantly found among the beams of the gastral layer where it is often seen in patch-like congeries.

The following table may serve to show the relative proportion in which the three above-described discohexaster-forms occur in differently sized individuals of the species :

Specimen.	Size of specimen.	Discohexaster		
		Form <i>a</i> . Smallest form like figs. 4-6, Pl. V.	Form <i>b</i> . Moderately large form like fig. 14, Pl. V.	Form <i>c</i> . Largest form like fig. 9, Pl. IV.
The 3 small specimens shown in fig. 9, Pl. V. (Sci. Coll. Mus. No. 407).	3-11 mm. high.	Numerous in both body and basidictyonalia.	Few.	Not found.
The nut-sized specimen shown in fig. 8, Pl. V. (Sci. Coll. Mus. No. 407).	31 mm. high.	Few, though common in basidictyonalia.	Common.	Common.
The specimen shown in fig. 10, Pl. V. (O. C. No. 4386).	156 mm. high.	Not found. (Basidictyonalia not preserved).	Not found.	Very common.
The specimen shown in the woodcut on p. 54 (O. C. No. 106).	185 mm. high.	Not found in body, but present in basidictyonalia.	Rare.	Very common.
The specimen shown in fig. 1, Pl. IV. (Sci. Coll. Mus. No. 443).	Very large.	Not found. (Basidictyonalia not preserved).	Rare.	Very common.

The above data seem to allow the following general observations to be made. In an early stage of the sponge's growth the discohexasters are mostly of the form *a*, only a few of the form

*b* being found and as yet none of the most highly developed form *c*. With the growth of the sponge, *a* diminishes in number and finally disappears altogether in the parenchyma, apparently as the result of its transformation into *b*; though it seems to persist in the original condition in the basidietyonal plate. At the same time, *b* in its turn is constantly developing into *c*, and when this development is quite or nearly completed as in all the larger specimens, the latter form becomes almost the only one that is to be met with in the parenchyma.

The second kind of hexasters constantly present in the species may be called the sigmatocome (Pl. IV., figs. 2 and 3; Pl. V., fig. 11). Here we have to do with small and delicate-looking rosettes measuring only 50–64  $\mu$  in diameter. In general shape and in the proportion of parts they closely resemble Euplectellid floricoes, except in that each perianth of terminals is somewhat more expanded and in that the terminals are conically pointed at the outer out-flaring end instead of having toothed plates. About a dozen or more, slender and distally gradually thickened terminals spring in a single whorl from the margin of a plano-convex disc at the end of each moderately long principal. In some rosettes, assumably those in an early stage of development, both the principals and the terminals are considerably thinner than in others.—The sigmatocome is found even in the smallest specimens shown in Pl. V., fig. 9, though not in so great abundance as in all larger individuals. In these it is of common occurrence in the parenchymal septa; it occurs much less frequently in the gastral layer also. On the surfaces of parenchymal septa, it is quite common to see the rosette shifted out to the tip of the free ray of canalar oxyhexactins (Pl. IV., fig. 8; Pl. V., fig. 12),

exactly after the manner of Euplectellid floricoes. I have found this to be of much more general occurrence on the excurrent, than on the incurrent, surface of parenchymal septa. Sometimes, as before mentioned, a sigmatocome has been found hanging on the end of an outstanding spicular ray which belonged to an indubitable parenchymalia.

**CHAUNOPLECTELLA SPINIFERA. N. sp.**

Pl. V., figs. 14-17 and Pl. VI., figs. 1-8.

In the Science College Collection I have discovered a specimen (No. 459) which bears close resemblance to *Chaunoplectella cavernosa* but seems to deserve erection into a distinct species. I propose to call it *Chaunoplectella spinifera*, in view of the spine-bearing character of some of its dermalia.

Another, much smaller and evidently very young specimen (Sci. Coll. Mus. No. 435), which I am inclined to refer to the same species, has also come under my observation. As it differs in some respects from the type-specimen, it will be well to treat of it separately. I shall refer to it as the second specimen.

The type-specimen (Pl. VI., figs. 1-8) comes from Homba, Sagami Sea, where it was taken at a depth of about 572 m. (= 313 fathoms). It is unfortunately incomplete in that it lacks the basal part, which had been torn off and lost. It represents a thick-walled sac of about the size and shape of a small plum, measuring, say, 30 mm. in diameter. The wall is 9 mm. thick in the thickest part; it thins but little towards the sharp-edged oscular margin, which is only partially preserved. The osculum

must have been roundish, measuring about 15 mm. across. The texture of the sponge is quite light, soft and fragile. The spicules are all very fine and loosely interwoven; they do not combine to form bundles of a noticeable strength, except in the region of the severed base. Both the external and internal surfaces are covered with a loose, delicate and irregular interlacement of the dermalia and the gastralia respectively, beneath which are seen canalar apertures not more than 2 mm. in diameter.

The second specimen was found in the same bottle together with specimens of *Lanuginella pupa*. The locality is Outside Okinosé; depth unknown. The small body is barrel-shaped, measuring only 9 mm. in length and 4 mm. in breadth at the middle. Wall up to  $1\frac{1}{2}$  mm. in thickness. An osculum of 1 mm. diameter occupies one end, while the other end is provided with a basidietyonal mass. Macroscopically the specimen presents no specially characteristic feature. Suffice it to say that, without studying its spiculation, it might easily pass for a young *Chaunoplectella cavernosa* or for a *Leucopsacus* or a *Lanuginella*.

### Spiculation.

First, as to the spiculation of the type-specimen. As in general appearance of the sponge, so also in this respect there is observable a near approach to the young *Chaunoplectella cavernosa*.

The *parenchymalia* consist of hexactins and diactins. No other forms of spicules have been found amongst them.

The hexactinic *parenchymalia* are of quite variable dimensions,



While many exhibit rays about 2 mm. long and  $40\ \mu$  broad near the spicular center, others are smaller, leading down to those which are one-fourth the size just mentioned or even smaller. Occasionally we meet with very small and fine-rayed hexactins, measuring  $200\ \mu$  or less in ray-length and only about  $2\ \mu$  in breadth of rays near the center. In one and the same parenchymal hexactin the rays are frequently of markedly unequal length. They are sometimes nearly straight, at other times somewhat bent. They are usually smooth throughout and taper gradually towards the sharply pointed end. See Pl. VI., fig. 8.

The diactinic parenchymalia play a comparatively less important part in the composition of the parenchyma, though they can not be said to be sparse in quantity. They mostly occur in small loose strands running in company with the rays of hexactinic parenchymalia. In the basal region of the sponge, however, the diactins combine to form bundles of a rather conspicuous strength and seem to constitute the principal mass of the parenchyma in that region. They are long and slender, being mostly under  $14\ \mu$  in thickness, though there occasionally occur much thicker ones among the bundles of the base. The center is externally smooth or else is provided with an annular swelling, rarely with four cruciate knobs. Ends rough-surfaced, usually slightly swollen and conically pointed.

The *gastralia* are variously sized oxyhexactins which in no way differ from those of the parenchyma. In forming the gastral layer they are loosely and irregularly interlocked with one another, but always projecting one of the rays into the gastral cavity. Diactins are not found in the layer.

The *dermalia* are oxypentactins, which differ but little from parenchymal oxyhexactins except in having one ray less. All the rays are straight or nearly so. The cruciate paratangential rays are in most cases  $\frac{1}{2}$ – $1\frac{1}{2}$  mm. long as measured from the center; the unpaired proximal ray is often twice as long as the paratangential in the same spicule, and sometimes even longer. Uniformity of size can not therefore be attributed to the dermalia. Not infrequently we meet with exceptionally small and fine-rayed dermalia, which likely are still in an incomplete state of development. Now, what seems to constitute a characteristic feature of the species is the fact that the paratangentials in certain dermalia—not in all—are peculiarly spined (Pl. VI., fig. 2). The slender and sharply pointed spines, sometimes small but sometimes  $90\mu$  long, are situated in a row on the outer side of paratangentials, at wide but indefinite intervals (of  $34$ – $150\mu$ ). As seen in lateral views of paratangentials, the spines mostly start out nearly erect at base but are usually gently curved one way or the other. They never occur numerously, their number on a single ray being not more than six; often there are only one or two to a ray. Dermalia thus spined are common among the medium-sized elements of the layer. The largest dermalia are, like the smallest, unspined. The paratangentials with spines are seen to run sometimes over, and sometimes under, those without spines. In fact, it seems there exists no rule as to the relative position in layers of the spiny and the smooth dermalia of various sizes. The thin dermal latticework formed by the intersecting of paratangentials at various angles is irregularly meshed. (In the upper part of fig. 8, Pl. VI., the dermal latticework is represented, not in section, but as seen obliquely *en face*).

The *hexasters* are discohexasters (Pl. VI., figs. 3-7) of varied size and appearance, occurring very commonly in the parenchyma. Of them I may distinguish at least four varieties, which however completely grade over into one another by intermediate forms, so that a sharp demarcation can not be drawn between them.

In the first place, there occur, especially abundantly in the peripheral part of the body, small and spherical or nearly spherical forms of discohexasters, of which fig. 3, Pl. VI., may be considered a typical representative. It closely resembles the form *a* of the discohexasters of *Ch. cavernosa* (p. 66). Diameter, 64-90  $\mu$ . Each principal, which can not be said to be very short, bears a bunch of 5, 6, or more terminals. These are smooth-surfaced and thicken slightly towards the outer end; they so diverge that the terminal discs in the entire rosette are nearly equidistant from one another. The discs are small, watchglass-like and outwardly convex; their margin shows 6-8 small teeth.

Common in the deeper parts is a second variety of discohexasters, distinguishable from the first by its larger size and by a tendency of the terminals to each principal to form a separate tuft (Pl. VI., figs. 4 and 5). Diameter, 90-160  $\mu$ . The terminals, smooth and outwardly somewhat thickened, number 6-9 to each principal. The discs at the ends have small marginal teeth, just like those exhibited by the variety first mentioned.

A third variety of discohexasters is made up of those which form the largest rosette of the species and in which each long and slender terminal is capped with a disc composed of 4-6, moderately large, recurved prongs arranged in a whorl (Pl. IV., fig. 7). In appearance it is very much like those discohexasters in *Ch. cavernosa*, which I have called Form *b*. Diameter, up

to  $230\ \mu$ . Such large discohexasters are not uncommonly found together with the second variety.

As a fourth variety of discohexasters may be mentioned the form shown in fig. 6, Pl. IV., which form is but rarely met with in the parenchyma. It is characterized by very slim terminals, grouped in separate, narrow and outwardly somewhat expanding tufts. The terminal discs are rudimentary and pinhead-like in appearance. The diameter, in one that I measured, was  $144\ \mu$ .

The delicate sigmatocome, which I have discovered in even the smallest specimens of *Ch. cavernosa* at my disposal, has not been found in the present species.

The second and much smaller specimen, which I refer to the present species, is, I should say, essentially the same in spiculation as the type, but with such points of deviation as are indicated below.

None of the dermalia show spines on the paratangential rays. This however I consider as due to the young state of the specimen. Probably the spines develop after the sponge has come nearer to maturity.

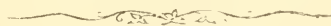
Of the discohexasters, the commonest form (Pl. V., figs. 15 and 16), corresponding in general shape to that which I have called the first variety in the type specimen, has a smaller number of terminals (usually 3 or 4) to each principal. Diameter,  $54\ \mu$  and upward to  $100\ \mu$  or over.—The second variety of the type seems to be wanting here; but perhaps it is to be considered as being represented by the larger of the rosettes that I have just now compared to the first variety.—The third variety is well represented though not in abundance; an example of it is shown in fig. 14, Pl. V. Diameter,  $200\ \mu$ . The discohexasters thus far

indicated as being present in the second specimen are scarcely distinguishable from the like hexasters of *Ch. cavernosa*, and I should possibly have held the specimen to be a young individual of that species, had it not been for the total absence of the sigmatocome and for the not infrequent occurrence, near the gastral surface, of an exceedingly fine-rayed discohexaster-form (Pl. V., fig. 17), which is comparable to that which I have described as the fourth variety in the type specimen of *Ch. spinifera*. This discohexaster-form measures about  $80\mu$  or more in diameter; 3-5, filamentous and obsoletely rough-surfaced terminals, each with a small and minutely toothed terminal disc, form a more or less distinct tuft to each principal. It seems to pass over gradationally into the third discohexaster-form, as this likewise does into the first.

A thorough examination of the slide-preparations, into which the entire specimen was converted, revealed a single case of a strobiloplumicome being included in the tissues. I can not but think that this is extrinsic,—that it originally belonged to *Lanuginella pupa*, together with which the specimen had been thrown in the same bottle.

After all, the peculiarities which the spiculation of the second specimen presents in comparison with the type, I consider as due merely to individuality.

The basidictyonalia, preserved in the second specimen, presents much the same characters as that of *Ch. cavernosa* (Pl. V., fig. 13).



## CAULOPHACIDÆ.

The idea of this new family has been conceived by me for the reception of certain genera from the ranks of F. E. SCHULZE's Asconematidæ, all the rest of this old family being given over to the Rossellidæ. The genus *Asconema* being one of those thus removed, it is self-evident that the remaining Asconematidæ require a new denomination.

The Asconematidæ, when last treated of by F. E. SCHULZE ('99, p. 98), were made to comprise those "lyssacinen Hexasterophora, deren Autodermalia und Autogastralia aus pentactinen oder hexactinen Pinulen mit vorragendem bedornten Radialstrahle bestehen." Seven genera were then referred by him to that family, viz., *Asconema* SAV. KENT, *Hyalascus* IJ., *Caulophacus* F. E. SCH., *Aulascus* F. E. SCH., *Sympagella* O. SCHM., *Calycosoma* F. E. SCH. and *Calycosaccus* F. E. SCH. At the same time that experienced writer himself expressed, as on an earlier occasion, his conviction that the Asconematidæ and the Rossellidæ would not hold out long as separate and distinct families. That he kept up the former family, as he did, was due more to his careful consideration of our yet defective knowledge of the forms concerned, than to any other reason.

After some deliberation I have come, as already indicated, to entertain the view that, while a total amalgamation of the two families seems not advisable, several of the genera mentioned above may even now be annexed to the Rossellidæ with advantage to the system.



From the above assemblage of seven genera may be separated *Caulophacus*, *Aulascus* and *Sympagella*, as having a number of important systematic characters in common, by virtue of which common points they, as a group, seem to be clearly distinguishable not only from all the remaining genera, but also from the Rossellidæ. This group—an intimately coherent group—it is, which, I think, deserves institution into a distinct family, the Caulophacidae. Since *Aulascus* appears to me as unitable with *Sympagella*, this family may in fact be said to be made up of only the two genera, *Caulophacus* and *Sympagella*. In both these genera the body is probably always provided with a long and distinct stalk;\* the dermalia and gastralia are invariably *pinules*, in which the freely projecting pinular ray is always of a characterization *markedly different* from that of any other ray in the same spicule; the rosettes are mainly discohexasters, while oxyhexasters may be said to be generally totally wanting.\*\*

Whereas, what remain of the Asconematidae, *viz.*, the four genera *Asconema*, *Hyalascus*, *Calycosoma*, and *Calycosaccus*, constitute a rather heterogeneous assemblage. In contrast to the Caulophacidae, they have a body which never seems to exhibit a long, distinct stalk; the freely projecting ray of the dermalia and gastralia is either not at all or comparatively but little differentiated from other rays in the same spicule; the rosettes always include an abundance of oxyhexasters, occurring in addition to either discohexasters or some other hexaster variety. The combination of the above-indicated common features suffices to

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\* Only in *Sympagella* (*Aulascus*) *johnstoni* has the presence of a stalk not been determined, the species being known from an incomplete specimen lacking the basal part.

\*\* Oxyhexasters are known from *Sympagella nux* only, in which they occur but rarely and inconstantly; so that, they have been put by F. E. SCHULZE ('99, p. 34) under the uncharacteristic hexaster varieties or aberrations of the species.

distinguish every one of the genera in question from the Caulophacidae (*cfr.* above), while at the same time it seems to bring them within the diagnostic scope allowable for the Rossellidæ.

F. E. SCHULZE ('99, p. 101) looks upon the absence of a *pinular* distal ray to dermalia as the principal family-character of the Rossellidæ. Not that Rossellid dermalia should always lack a distal ray, but he in fact includes, and quite rightly I believe, the hexactinic form within the range of their legitimate variation, with the restriction that the one necessarily distally directed ray in such hexactins should not be pinularly developed but simple and similar in appearance to the other rays. Thus, in *Aphorme horrida* F. E. SCH.\* ('99, p. 41), and in a manner also in *Trichasterina borealis* F. E. SCH. ('00 b, p. 103), the dermalia are said to be hexactins, while cases of other Rossellids with well-developed hexactins occurring sporadically among the dermalia are by no means rare (e. g., *Rossella nuda* Tors., *R. racovitzae* Tors., *Rhabdocalyptus tener* F. E. SCH., *Acanthascus platei* F. E. SCH.). I have expressly referred to the above point because the dermalia of the Rossellidæ were originally considered to be always without a distal ray (Chall. Rep., pp. 129, 374) in contrast to those of the Asconematidæ,—a fact which apparently has had influence in maintaining the *status quo* of the latter group.

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\* I must say that the small slender-rayed "oxyhexactins," taken by F. E. SCHULZE for the dermalia of *Aphorme horrida*, are probably not real hexactins but oxyhexasters of hexactinose shape. I was strengthened in this belief on viewing under the microscope a preparation of the type-specimen, kindly shown me by Professor F. E. SCHULZE. The real dermalia of the species seem to be the stauractins called by him the hypodermalia, while these seem to be really represented in the large pentactins occurring as prostalia. A part of the hexactinose oxyhexasters had apparently secondarily taken up a position outside the dermal layer, a process probably analogous to the shifting of Euplectellid floricoles to the extreme outer end of dermalia. Notwithstanding the above facts, it is plain that F. E. SCHULZE is at one with me in the idea that forms with entirely hexactinic dermalia may be taken up under the Rossellidæ, if other characters permit it.

Now, as regards *Asconema* (with the single species, *A. setubalense*), the unpaired ray of its pentactinic dermalia and gastralria is, to judge from F. E. SCHULZE's description and figure (Chall. Rep., p. 117 ; Pl. XXI., fig. 4), scarcely differentiated in appearance from the paratangential rays. It is exceedingly doubtful if it can at all be called pinular. The mere fact that the unpaired ray in those pentactins projects freely outwards and does not dip into the body-wall, appears to me a much too slight and unreliable ground for excluding the genus from the Rossellidæ. This I say, not only on a general consideration of the wide variability—ranging from hexactins down to diactins or even to monactins—exhibited by dermalia in that family, but also in view of the fact that in *Lophocalyx spinosa* F. E. SCH. ('00, p. 37) we have a Rossellid in which there occur, together with stauroactinic dermalia, others that are pentactinic and have the unpaired ray directed outwards. I consider the dermalia of *Asconema* to have been directly derived, by atrophy of the proximal ray, from such simple hexactinic forms as are sometimes shown by certain Rossellids,—not from such hexactinic *pinules* as are possessed by *Caulophacus*, as the pentactinic *pinules* of *Sympagella nux* unquestionably are. The same should hold good *mutatis mutandis* for the gastralria also. Exceptional as the condition certainly is, the pentactinic dermalia and gastralria with the unpaired *simple* ray directed away from the body are, in my estimation of their bearing on the systematic, no farther removed from the original simple hexactinic form than are those—so commonly met with in the Rossellidæ—in which the unpaired ray is directed the other way. After all, I think that, if *Asconema* is to be kept separate from the Rossellidæ, it should rather be removed from association in the same family with *Caulophacus* and *Sympagella*.

*Hyalascus* is a genus instituted by me in '96 to receive the single species then known to me, *H. sagamiensis* IJ. In this species the dermalia are partly pentactins and partly hexactins, the former with the unpaired ray directed *proximad* and the latter with the distal ray in no way differently characterized from the other rays. In a second species, referable to the same genus which has since become known to me (*H. giganteus* n. sp.), the dermalia are mostly pentactins with the unpaired ray directed proximad and a distal sixth ray represented by a knob, and occasionally stauractins and simple hexactins. In '96 I was not quite certain as to which family *H. sagamiensis* should be referred and therefore had to satisfy myself with the remark that it was probably to be considered as a near ally of *Asconema*, without denying at the same time its close affinity to the Rossellidæ. I now see, in the nature of the dermalia or in any other respect of the spiculation, nothing that seems to stand in the way of placing the genus under the Rossellids, but much that indicates that it properly should be so placed.

I think the same may fairly be said of *Calycosoma* and *Calycosaccus*. In both, it may be said collectively, the dermalia are either hexactins or pentactins, in the latter case the unpaired ray being outwardly turned. So far the dermalia fall within the range of variability as assigned by me to those of the Rossellidæ (*cf. supra*). But the one point, which might possibly be considered—as indeed it was considered by F. E. SCHULZE—to interfere with the introduction of the two genera among the Rossellids, is the fact that the distal ray of the said dermalia shows a spindle-like swelling and exhibits prickles somewhat more strongly developed than those on the other rays, thus causing its resemblance to a pinular ray. But the resemblance can by no means

be called complete, and probably nobody will hold it, by itself, as a character adequate to base a family on. In all other respects the two genera in question are both quite like Rossellids; the somewhat special development shown by the freely projecting ray of their hexactinic gastralia is of no moment, since the same feature is not infrequently observable in Rossellids of unquestionable status (e. g., *Rhabdocalyptus nodulosus* F. E. SCH., *Rh. tener* F. E. SCH., *Rh. mirabilis* F. E. SCH., &c.). With respect to *Calycosaccus*, it has even been stated by F. E. SCHULZE the describer, ('99, p. 100), that he would not have hesitated to regard it as identical with the Rossellid genus *Aulosaccus* L., if only the unpaired ray of its pentactinic dermalia had been directed proximad instead of distad. So that, while the two genera seem unitable to the Rossellidæ, they may, for the reason already advanced, be kept separate from the group that I have called the Caulophacidæ.

*Calycosoma* (with the single species, *C. validum*. F. E. SCH.) had probably best be received into the subfamily Lanuginellinæ, especially on account of the strobiloplumicome present in it. Whereas, *Calycosaccus* (likewise with a single species, *C. ijimai*) is to be placed in the subfamily Rossellinæ in direct proximity to, if not in amalgamation into *Aulosaccus*. I may here add that to the same subfamily should also belong *Hyalascus* and *Asconema*. The three genera herewith referred to the Rossellinæ show no sign of specially close bonds of relationship between them, when considered in relation to other Rosselline genera.

But to return to the Caulophacidæ. Its near affinity to the Euplectellidæ is undeniable, so much so that *Saccocalyx pedunculata* F. E. SCH., now recognized as an Euplectellid, was at first



regarded as an Asconematid evidently on account of its resemblance in both general shape and spiculation to *Caulophacus* or *Sympagella*. On the other hand, a relationship, about equally close, to the Lanuginellinæ under the Rossellidæ seems to be indicated by the fact that *Sympagella* is in possession of the strobiloplumicome, a peculiar form of rosette present in all the Lanuginelline genera. An intermediate position between the Euplectellidæ and the Rossellidæ is therefore to be ascribed to the Caulophacidæ.

I define the family as follows :

Lyssacine Hexasterophora of cup-like or mushroom-disc-like body; always stalked and firmly attached at base; solitary or forming a small branched colony by budding. Dermal skeleton composed of small hexactinic or pentactinic pinular dermalia and of large pentactinic hypodermalia. Hexasters represented mainly by discohexasters, either alone or in company with strobiloplumicome.

The two genera composing the family are so joined to each other by an interchange of their characters that a statement of their differential points, which will hold good for all the cases of species, can only be made in the most meager terms as follows :

- A.—With strobiloplumicome among the hexasters .....*Sympagella* O. SCHM.  
 B.—Without strobiloplumicome among the hexasters..... *Caulophacus* F. E. SCH.
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## CAULOPHACUS F. E. SCH.

*Balanites*, F. E. SCH., '86 ; '87, pp. 122, 372.

*Balanella*, F. E. SCH., '87 (postscript).

*Caulophacus*, F. E. SCH., '86 ; '87, pp. 124, 373 ; '97, p. 525.

Caulophacids of cup-like or fungiform body ; solitary (always ?). Parenchymalia chiefly diactins but including also large regular hexactins. Dermalia, hexactinic pinules ; on the stalk these may be replaced by pentaactinic forms. Gastralia, either hexactinic or pentaactinic pinules. Discohexaster present in varying forms ; *without* strobiloplumicome.

Noteworthy is the fact that in most species (probably all except *C. lotifolium* n. sp.) of the genus the unpaired ray of the pentaactinic hypodermalia and hypogastralia is beset with prickles throughout nearly its entire length. Further, in most species (the exception being again *C. lotifolium*) the discohexaster occurs in two easily distinguishable types, which I shall call, for the sake of easy reference, the *pachydiscohexaster* and the *lophodiscohexaster*. The former has thick, thorny or barbed, widely diverging terminals ; it is frequently hemihexactinose or hexactinose, and in some species occurs in the hexactinose form only. The latter has much thinner terminals, which form a distinctly separate tuft of bell-like or elongate-conical shape to each principal.

The following is a key to the five known species of this genus :

- a.*—Body cup-like; or, the principals of hexasterous discohexasters (of both types) much longer than the terminals ..... *C. pipetta* F. E. SCH. (Antarctic Ocean).
- b.*—Body fungiform, with the gastral surface outwardly exposed; or, the principals of hexasterous discohexasters (of both types) nearly equal to or shorter than the terminals.
- a*<sup>1</sup>.—Gastralia are predominantly pentactinic pinules; or pachydiscohexasters represented by hexactinose forms only.
- a*<sup>2</sup>.—Pinular ray of dermalia mostly ovoid; or, the slender pinular ray of gastralia nearly 1 mm. or more in length; or the terminal tuft of lophodiscohexaster nearly as long as the principal; or, the unpaired radial ray of hypodermalia and hypogastralia echinated throughout nearly the entire length ..... *C. latus* F. E. SCH. (South Indian Ocean).
- b*<sup>2</sup>.—Pinular ray of dermalia slender and sharply pointed at apex; or, the slender pinular ray of gastralia less than  $\frac{1}{2}$  mm. in length; or, the terminal tuft of lophodiscohexaster 3-4 times longer than the principal; or, the unpaired radial ray, as also other rays, of hypodermalia and hypogastralia echinated at base....  
..... *C. agassizi* F. E. SCH. (Atlantic Ocean).
- b*<sup>1</sup>.—Gastralia are hexactinic pinules; or, pachydiscohexasters represented by hexasterous, hemihexactinose and hexactinose forms.
- e*<sup>2</sup>.—The unpaired radial ray of hypodermalia and hypogastralia echinated throughout; or, pachydiscohexasters over 150 $\mu$  in diameter ..... *C. elegans* F. E. SCH. (North Pacific Ocean).
- d*<sup>2</sup>.—The unpaired radial ray of hypodermalia and hypogastralia smooth, being rough-surfaced only at the end; or, pachydiscohexasters under 115 $\mu$  in diameter. Lophodiscohexaster not present..... *C. lotifolium* IJ. (Sagami Sea).

Besides the five species\* embodied in the above, a case of undeterminable *Caulophacus* from off the coast of Maryland is mentioned in F. E. SCHULZ'ES "Amerikanische Hexactinelliden" ('99, p. 39). The specimen consisted of only the stalk and the basal disc, but the hexactinic pinular dermalia and the nature of the hexasters found in it attest the correctness of the generic identification. As to the completely macerated pieces of tubular stalk from the Antarctic mentioned by TOPSENT ('01) as *Caulophacus* sp., nothing can be said except that that writer was perfectly justified in attaching a query to the name.

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\* The specimen from the Antarctic, on which F. E. SCHULZE based his *Pleorhabdus oviformis* (Chall. Rep., p. 121 and P. S.) is evidently a *Caulophacid*. Were it not for the fact that that genus and species was withdrawn from the system by the original describer ('97), I might have regarded *Pleorhabdus*, on the strength of the description and figures given in the Chall. Rep., as identical with *Caulophacus* and thus added a sixth species to the list; but as the matter now stands, it has to be entirely left out of consideration.

Here let me give the description of the only sepecies that has as yet been obtained in the Sagami Sea.

**CAULOPHACUS LOTIFOLIUM. N. SP.**

Pl. VII.

This species is founded on a unique specimen which was obtained by KUMA from a depth of about 572 m. (313 fms.) in Maye-no-Yodomi, Sagami Sea. It passed into the possession of MR. ALAN OWSTON, while a small piece cut from it and thrown into alcohol on the spot was sent to me by the collector. The specimen, well preserved in the dried state, was subsequently purchased by DR. LAMPERT of the Kgl. Naturalien Kabinet in Stuttgart, in which institution it is now preserved.

In general shape and appearance the type specimen (Pl. VII., fig. 1) reminds one of a drooping lotus-leaf; hence the specific name. The apex of the inverted-conical body is continued below into a long crooked stalk. The latter expands at the lower end into an irregular basal mass, by means of which the sponge was attached to a tufaceous substratum.

If the stalk had been straight, the entire specimen would have measured no less than 410 mm. in height, about three-fourths of this measurement appertaining to the stalk. The body proper measures 132 mm. across the broadest part. The stalk is 8-11 mm. thick in the middle part.

As in *C. elegans*, *agassizi* and *latus*, the gastral cavity is turned entirely inside out, its surface thus forming the upper terminal surface of the inverted-conical sponge-body. A not

inconsiderable part of the periphery of this surface is reflected outwards and backwards, forming at one place an ear-like flap almost touching the lateral surface. The irregular gastral surface is much folded and creased, which may have occurred in the desiccating process. It is covered all over with an extremely delicate gastral layer, which is supported on fine hypogastral fibers barely distinguishable to the naked eye. Through and close beneath the layer are seen the apertures of excurrent canals. These are minute near the oscular rim but become larger towards the center, where they mostly measure about 2 mm. though some are as much as 6 mm. in diameter. The larger apertures lie separated from one another by a space usually narrower than their own width.

That the above considered terminal area of the sponge is the gastral surface, is placed beyond the reach of doubt by the fact ascertained by direct observation, that the chamber layer beneath it has the apophyses turned towards that surface.

The oscular edge is sharp, though not thin. No prostalia marginalia are seen along it.

The lateral surface of the sponge-body shows a dermal skeleton of exquisite beauty. The dermal layer is exceedingly fine and delicate; its minute meshes are just discernible as such with the naked eye. It is borne on two sets of hypodermal latticework. Of these one is formed by the paratangentials of pentactinic hypodermalia (Pl. VII., fig. 19). This is quite delicate, presenting small meshes which are generally regularly rectangular and measure only about half a millimeter in the length of sides. The other hypodermal latticework is formed of fibrous bundles of varying caliber. It is the coarsely and irregularly meshed latticework that is prominently visible in fig. 1, Pl. VII. In some

places the bundles are fully 2 mm. thick ; in others they are quite fine. The coarser bundles are seen to run from the narrow end of the body divergingly towards the oscular edge, interposed between the dermal layer and the choanosomal mass. On the way thither they frequently divide and unite or send out anastomosing branches. The finer bundles stretch over the subdermal space entirely separate from the choanosome but in union with the dermal layer.

Through the dermal layer and separated from it by the subdermal space which varies in width in different places, are seen the roundish or oval entrances into incurrent canals. These do not exceed 6 mm. in diameter.

Towards the narrow end of the body and on the stalk, the dermalia lose the lattice-like arrangement and become so densely crowded together as to form a smooth compact coating of frosted appearance. The coating easily falls off and, in the greater part of the lower two-thirds of the stalk, is lost. The surface thus exposed is soiled and has given attachment to a creeping Hydroid stolon. Except in the upper end the stalk is quite firm, owing to an extensive synapticular fusion of spicules. This fusion is however not participated in by the dermal pinules and the hypodermal oxypentactins, nor by the hexasters present in that region. Superiorly the fusion gradually disappears and at the junction with the sponge-body all the spicules are loose, the parenchymalia here running parallel and densely packed together but soon to split above, as far as seen on the surface, into the coarse hypodermal bundles before mentioned.

The stalk is hollow, being axially traversed by a canal measuring 3 mm. or less in diameter. It may therefore be said to be a thick-walled tube. The lumen is evidently an extension

of the excurrent canal-system. There certainly does not exist any direct connexion between it and the gastral surface.

The texture of tissues in the sponge-body is markedly soft and delicate, which is due to the fineness of all the spicules.

### Spiculation.

The *parenchymalia* consist mainly of diactins, intermixed with which are however a not inconsiderable quantity of regular hexactins.

The diactins run either isolated or in loose or compact bundles. They are all short and thin, seldom exceeding 2 mm. in length and  $15\mu$  in breadth. The spicular center is usually plain, only occasionally supplied with an annular swelling. The breadth generally remains nearly the same in the greater part of the rays. The terminal roughened portion is often slightly swollen before ending in a rounded or a conical point. In the compact wall of the stalk, the diactins, in the main longitudinally disposed, are generally somewhat longer and frequently as thick as  $35\mu$ . Here the rough ends are often swollen in a knob-like manner. There is nothing in the synapticular formations in the stalk requiring particular mention.

The parenchymal hexactins have straight smooth rays, which gradually taper towards the sharply or bluntly or conically pointed, slightly rough-surfaced end. In these characters they agree well with both the hypodermal and the hypogastral pentactins; so also in dimensions in the generality of cases, but sometimes they are considerably larger and stronger (figs. 18 & 21). The axial length may reach 1.6 mm.



The hypodermal, anastomosing bundles of fibers, which may be considered as a part of the parenchymal skeleton, seem to consist of the diactinic elements only.

The *hypodermal pentactins* in the sponge-body measure commonly between  $300\mu$  and  $600\mu$  in length of paratangential rays. The proximally directed, unpaired ray is usually longer than, but never so much as twice, the length of the paratangentials in the same spicule. Thickness of rays near the center  $23-30\mu$ . The rays gradually attenuate towards the more or less conically pointed end. Their surface is smooth except for a very short space at the ends, which are rough. This holds true of all the rays, not excepting the proximal ray, which in all other known species of the genus seems to be echinated throughout almost its entire length. The paratangentials form the delicate, more or less regularly quadrate-meshed, hypodermal latticework before mentioned (fig. 19).—In the stalk, especially in its lower part, the hypodermal pentactins (of which two are shown in fig. 20) are much smaller than in the body. Length of paratangentials  $100\mu$  on an average; the proximal ray 3–4 times as long, sometimes bearing on the surface a small number of minute prickle-like points. The pentactins are here irregularly scattered.

As *hypogastralia* there occur pentactins similar in all respects to the hypodermalia of the body (fig. 21); only they are distributed without order as to the mutual relation of the cruciate paratangentials, so that these do not exhibit a checker-like arrangement. They may associate with some parenchymal diactins in forming the thin hypogastral strands.

The *dermalia* (fig. 3) are exclusively hexactinic pinules, so far as those of the body proper are concerned. The pinular ray as a whole is spindle-shaped; it is 120–140  $\mu$  long and 30–42  $\mu$  broad in the middle, which is about the broadest part. In this part, the obliquely upwardly directed, elongate conical spines may be as long as 23  $\mu$ . The rhachis is smooth for a short distance at the base, which is about 11  $\mu$  thick; its conically pointed, outer end forms the tip of the pinular ray. The remaining five rays are all more slender, and gradually taper towards the conically or bluntly pointed end. They are beset with small, generally erect prickles, sparingly at the base but more numerous at the end. Length 88–120  $\mu$ . The proximal ray is usually slightly shorter than the paratangentials of the same pinule. As is usual, two paratangentials of every two adjoining pinules lie side by side for nearly their entire length, the result being the fine, quadrate-meshed dermal latticework (fig. 19), in which each mesh has sides approximately equal in length to that of the rays concerned in inclosing it. As ascertained on sections, the said latticework does not lie in direct contact with the underlying hypodermal paratangentials but is separated from these by a space about as wide as, or slightly less wide than, the length of the dermal proximal rays (fig. 18).

Here and there among the *dermalia* of the body I have met with such forms as may appropriately be regarded as early stages of their development. They are comparatively small and slender-rayed hexactins, in which the distally directed (the future pinular) ray is not at all or but little differentiated from the other rays, being nearly as prickly as these.

In the upper part of the stalk, the pinules retain the characters described above; but they are here much more closely packed

together, the checker-like arrangement of paratangentials totally disappearing. Lower down on the stalk, where the parenchymalia have undergone ankylosis, the hexactinic pinules gradually pass over into a peculiarly modified, pentactinic form, in which the suppressed proximal ray is however frequently indicated by a small prominence (figs. 9-11). The persisting rays are much thicker than the corresponding rays in a normal pinule of the body, and what at once strikes the eye is the greatly swollen state of the unpaired free ray, especially at its distal end. In this way that ray acquires a club-like, or more generally a balloon-like, shape. The swollen end is densely covered with short but stout, conical tubercles, which become less numerous below on the stalk-like part of the ray, finally to disappear altogether at the base of that part. The terminal globular knobs often measure  $95\mu$  in diameter, but are of various sizes leading down to a club-like shape of  $35\mu$  breadth. In surface view under a low power of the microscope (fig. 20), the dermal coating of the stalk appears as if consisting of rough-surfaced spherules closely crowded together. A similar change in the character of dermalia on the stalk has been known in *Caulophacus elegans* F. E. SCH. ('87) and *C. agassizi* F. E. SCH. ('99, p. 39).

The *gastralia* (figs. 2, 21) are likewise hexactinic pinules; rarely pentactinic, the aborted distal ray being represented by a mere knob. The free pinular ray, compared with the same of normal dermalia, is much longer and proportionally more slender. It is  $220-300\mu$  long and about  $30\mu$  broad as measured across from tip to tip of the strongest lateral spines in about the middle of the ray. The axial rhachis, about  $12\mu$  thick at base, gradually tapers towards the sharply pointed free end. The five remain-

ing rays are exactly comparable to the corresponding rays of dermalia, except in the fact that they are perceptibly longer. Length of paratangentials  $110-132\ \mu$ ; that of the distal ray  $88-100\ \mu$ . The paratangentials are so arranged as to bring about a rectangularly meshed latticework, in the same manner as those of the dermalia.

The *hexaster* of the species consists of rough and thick-rayed discohexasters—evidently the pachydiscohexaster of other *Caulophacus* species—and their variations. Lophodiscohexasters are not present.

As the starting point of our description may serve the spherical or nearly spherical, normally developed discohexasters shown in figs. 4 and 5. Such a form occurs, together with certain varieties soon to be mentioned, in tolerable abundance in both the subdermal and subgastral regions, more commonly in the latter than in the former. It measures  $60-92\ \mu$  in diameter. In the larger and well developed cases (fig. 5), the principals are obsolete, making it difficult to determine the number of terminals borne on each. However, the usual number seems to be 3 or 4, perhaps occasionally 5. In smaller specimens of the hexaster (fig. 4) the principals are only just long enough to be distinguishable and each bears only 2, at most 3, terminals. In all these cases the terminals are thick (up to  $4\ \mu$  in breadth) and nearly straight or but slightly bent; they are profusely beset, throughout their length, with rather strong, retroverted prickles. The convex terminal disc exhibits 4-6, strong, recurved, marginal teeth.

The form just described is occasionally hemihexactinose (fig. 6) and frequently hexactinose (figs. 7 and 8). The hexactinose

type is especially common in the choanosome; in fact, it may be said that almost all the discohexasters here present are of this form. The terminals are exactly comparable to those of normally developed discohexasters. When hexactinose, the axial length may reach 115%, showing an increase in diameter over normal forms,—a fact which according to my experience, is generally observable in all lyssacine Hexactinellids having a hexaster in the two varietal forms mentioned. Fig. 7 shows a case of the hexactinose discohexaster, in which one of the six rays is bent at base, i. e., at the junction of the terminal with the principal, indicating its derivation from a dilophous ray by loss of one of the two terminals. Fig. 17 shows the extent of the axial cross in a hexactinose discohexaster, it being limited in extent to the spicular center and the basal parts of the rays corresponding to the original principals.

Further variations—or possibly early developmental stages—of the discohexaster are seen in unusually thin-rayed and obsoletely rough or nearly smooth surfaced forms, such as are represented in figs. 12–16. Transitional forms connect them with the thick-rayed discohexasters, and they occur, together with these, not uncommonly in both the subdermal and subgastral regions, but especially in the latter. Sometimes they have all the principals supplied with 2, occasionally 3, terminals (fig. 14); at other times they are either hemihexactinose (figs. 12, 13, 16) or quite hexactinose (fig. 15). The terminal discs in a rosette of the kind may be in appearance similar to those in the thick-rayed discohexaster, except in being smaller and more weakly developed (figs. 12 and 13); or they may occasionally consist of 2–4, nearly transverse or outwardly diverging, slender claws at the ends of tapering terminals, in which case the rosette deserves to be called an

onychaster (figs. 14, 16). The said variation in the development of terminal discs occurs irrespective of the rosette being normally developed, hemihexactinose or hexactinose. In certain cases I have found the terminal claws branched (fig. 15).

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### SYMPAGELLA O. SCHM.

*Sympagella*, O. SCHMIDT, '70, p. 15.—F. E. SCHULZE, '86; '87; p. 119; '97, p. 528; '99, p. 32; '00 *a*.

*Aulascus*, F. E. SCHULZE, '86; '87, p. 118; '97, p. 527.

Caulophacids of cup-like body, showing tendency to form small colonies by budding. Parenchymalia as in *Caulophacus*. Dermalia, either hexactinic or pentactinic pinules. Gastralia, hexactinic pinules. Besides discohexasters, strobiloplumicome always present.

The new species to be presently described under the name of *Sympagella anomala* might, apparently with equal propriety be referred to the same genus as *Aulascus johnstoni* F. E. SCH. In fact, it appears to me that the genus *Aulascus* is scarcely sufficiently differentiated in characters to justify its separation from *Sympagella*. Hence I have placed it under the synonymy of the older name O. SCHMIDT'S in spite of F. E. SCHULZE'S ('97) opinion to the contrary. It seems to me fairly assumable



that the fragmentary specimen, on which the single species of *Aulascus* (*A. johnstoni*) is based, originally formed a part of an individual shaped somewhat like *Sympagella anomala* n. sp. The small rough "discohexactins" mentioned by F. E. SCHULZE as occurring in the parenchyma of *Aulascus* are evidently nothing else than hexactinose discohexasters. To them, as also to the presence of the pentactinic hypogastralia or of a proximal ray to the dermalia in that sponge, I can attach no more than specific importance.

The following contains all the more important differential points in the characters of, and will serve as a key to, the three species contained in the genus as defined by me.

- a*.—Body ellipsoidal and with a single osculum; borne on ends of branches of the ramified stalk. Dermalia pentactinic pinules; gastralia hexactinic with very slender pinular ray. Without hypogastral pentactins.....*S. nux*, O. SCHM. (N. Atlantic, Mediterranean)
- b*.—Body irregularly sacciform; incompletely divided into persons, each with an osculum. Dermalia and gastralia hexactinic; both with similarly shaped pinular ray.
- a*<sup>1</sup>.—Predominant discohexaster with rough-surfaced terminals, each ending in a small, slightly arched, transverse disc which marginally runs out into recurved prongs. With hypogastral pentactins.....*S. johnstoni* (F. E. SCH.). (Prince Edwards Is.)
- b*<sup>1</sup>.—Predominant discohexaster with nearly smooth terminals, each ending in a whorl of 2-6, very fine straight, forwardly and outwardly diverging branchlets (not recurved). Without hypogastral pentactins.....*S. anomala* n. sp. (Sagami Sea).

### SYMPAGELLA ANOMALA. N. SP.

#### Plate VIII.

A score or more of specimens of this new species have been at my disposal for study. They were all collected by KUMA from depths of 430-572 m. (235-313 fms.) in the Sagami Sea.

The more exact localities are : Maye-no-Yodomi ; Okinosé, both Inside and Outside ; Homba ; Gokeba.

The specimens are usually attached to the dead skeletons of other Hexactinellids, such as *Chonelasma calyx*, *Periphragella elisa*, *Hexactinella ventilabrum*, etc. In one case (Pl. VIII., fig. 1) about half a dozen small individuals of the species were seated on a large irregularly branching mass of a dead Hexactinellid skeleton, which on examination proved to be the stalk of an old individual, or individuals, of the same species as the living specimens borne on it.

The entire configuration of the stalked sponge is quite irregular ; hence the specific name I have given to it. The sponge-body proper may in general be said to be saccular or cup-like and more or less laterally compressed. The wall is moderately thick ; the oscular edge is simple and sharp, but not thin. In size the body may be nearly as large as one's fist. It usually bears, in indefinite positions, bud-like or tubular evaginations, each having an osculum at the end and leading into the common gastral cavity. In other words, the body appears to be composed of variously sized and incompletely divided persons. The number of these in each case is never numerous, being limited to four or five at the most.

The stalk is firm, branching and anastomosing ; it is at times moderately long, at other times rather short.

To illustrate with concrete examples, I have shown in fig. 2, Pl. VIII., a specimen measuring 168 mm. in total height in which the stalk is about as long as the compressed pouch-like body. The latter has a wall about 5 mm. thick in the thickest part. It seems to have originally borne no less than five buds or secondarily formed persons, of which two remain intact while

the rest have been torn off. The stalk shows an open perforation in the upper part; lower down it splits into two branches, each of which is inserted in a piece of dead *Chonelasma*.

Fig. 3, Pl. VIII., represents one of the largest specimen I have seen. It is 185 mm. high. The main body consists of two large persons joined together at base. One of them is irregularly tubular; the other is funnel-like, expanding above, and distinctly laterally compressed. Maximum thickness of wall, 9 mm. Four short and comparatively slender stalks proceed from the common base but unite below into one before forming a knob for attachment. On one side, one of the stalks sends out, obliquely downwards, a free ending branch which probably at one time was likewise fixed to the substratum.

The dead, irregularly branching stalk before mentioned and seen in fig. 1, Pl. VIII., is at places 15 mm. or more thick. Probably it represents fused stalks of several individuals. Of far greater interest are the small young specimens which are seen growing on it. These are of the size of a walnut or smaller and represent various stages of the change in form undergone by the sponge during growth. In an early stage the entire body is simply elongate-ovoid, being attached by the narrower end while in the opposite end opens a round simple osculum. One specimen in this stage of development measured only 14 mm. in length and  $6\frac{1}{2}$  mm. in breadth in the broadest part; breadth of stalk-like base  $2\frac{3}{4}$  mm; diameter of osculum 2 mm.; thickness of wall 2 mm. and under. This simple original form of the body is soon lost with the formation of buds. These are at first mere thickenings of the sponge-wall. They gradually take the form of a papilla-like protuberance and sooner or later a new osculum opens at the rounded apex. The gastral cavity of the bud in an early

stage of its formation either widely communicates with that of the mother or is apparently separate from, and independent of, this. The latter condition however passes ultimately into the former evidently by the widening of a connecting excurrent canal, as assumably the new gastral cavity itself likewise arose by the widening of an excurrent canal of the mother.

In some young specimens I have found, apart from the terminally situated osculum, a roundish gap in the wall, this being in no degree specially elevated at the spot. The gap is sometimes surrounded by a thin iris-like membrane. I consider this to be a secondarily formed osculum, formed either precociously at a place where an evagination of the wall may yet take place or as standing alone by itself for a person in suppression of the evaginating process. In the latter case, it would be exactly comparable to the openings which I have called parietal or secondary oscula in the Euplectellidæ.

The originally simple stalk may possibly send out off-shoots and thus change into the ramified condition seen in old specimens; but there are also other ways by which this may be brought about. Some of the little specimens above-mentioned are in contact with, and fixed to, the substratum at more than one point; in other cases, individuals of apparently separate origin but growing side by side are fused together in the upper part. In both cases the result is much the same, and it is easy to imagine that with the growth of the sponge there should arise as many stalks as there are points of attachment to the substratum with variations in their arrangement according to circumstances.

The even but gently undulating, external surface of the sponge-body is covered with the extremely fine and approximately quadrate-meshed dermal latticework (Pl. VIII., fig. 20), in which

the pinular rays can be discerned under the hand-lens as minute white spots. The meshes measure mostly 100–135  $\mu$  in length of sides. The hypodermal latticework presents meshes of triangular, trapezoidal, rectangular or irregular shape, with sides of 400–700  $\mu$  length. At places, especially in the lower part of the body, the thin hypodermal beams are more or less augmented in strength so as to appear like sinuous and intersecting fibrous bundles which are in no way distinguishable from those in the choanosoma. Through the dermal layer are visible the entrances into incurrents canals measuring 2 mm. and under in diameter.

The gastral surface (see fig. 3) is not covered over by a continuous gastral layer, but leaves open all the apertures of excurrent canals. These apertures are round and pit-like; they may measure 2 mm. across, but there exist all sizes down to those that can be called minute pores. Any two of the larger apertures may be separated from each other by a space up to 5 mm. in width which in turn is occupied by much smaller apertures down to the smallest. Altogether the appearance of the gastral surface closely resembles that in *Hyalonema affine*.

The stalk is firm. Unless denuded and the deeper fibrous texture exposed, it is densely covered with dermalia forming a pure-white powdery crust, which can be easily rubbed off. Internally it is almost solid, being at most traversed by a system of insignificant excurrent canals.

The color of the sponge in the fresh state is, according to the statements of KUMA the collector, light pinkish on the stalk, fading above into colorlessness on the body. The small specimens shown in fig. 1 retained that coloration for some time even after they were brought to me in the desiccated state.

As to the histology, no point of particular interest has

attracted my attention. The cup-like or thimble-like chambers measure 65–100  $\mu$  in diameter. In a certain specimen an unusually large quantity of yellow, refractive, fat-like spherules were observed hanging on the subdermal trabeculae (see fig. 22). In all probability they were products of the thesocytes.

### Spiculation.

The *parenchymalia* are predominantly slender diactins, arranged in loose bundles or running singly in indefinite directions. They are generally under 1.5 mm. in length and 27  $\mu$  in breadth in the middle; occasionally, somewhat longer than 2 mm. and 35  $\mu$  broad. The center is commonly even-surfaced; occasionally supplied with an annular swelling or with four knobs. The rays generally taper towards the end, which is conically pointed and subterminally rough-surfaced.

Included here and there among the *parenchymalia* are oxyhexactins of medium and small dimensions. In the character of rays these oxyhexactins are exactly comparable to the pentactinic hypodermalia, except that they are generally somewhat less strong. Axial length, mostly under 700  $\mu$ ; breadth of rays near the center, 15  $\mu$  and under. The smaller parenchymal oxyhexactins seem to pass over gradationally into the canalar oxyhexactins.

Exceptionally the *parenchymalia* are tauactinic and stauractinic. These forms are especially met with directly beneath the gastral layer and also along the canalar (both incurrent and excurrent) surfaces.



The pentactinic *hypodermalia* are of a moderately large size. Paratangentials as long as  $600\mu$ ; the unpaired proximal ray somewhat longer than the paratangentials of the same spicule; thickness of rays near the center, up to  $34\mu$ . All the rays, the unpaired ray not excepted, are straight and gradually taper towards the sharply pointed end, which is subterminally nearly smooth or sparingly supplied with obsolete microtubercles.

Pentactinic *hypogastralia* are, as a general matter, not present in this species. In this respect it is like *S. nux* (F. E. SCH., '97, p. 529) but unlike *S. johnstoni*. It is possible that their absence is in a measure compensated for by the occurrence, before mentioned, of parenchymal tauactins and stauractins in touch with the gastral layer.

The *dermalia* (Pl. VIII., figs. 4 and 5) are exclusively hexactinic pinules. The stoutly developed pinular ray is club-like or spindle-like in shape. Starting from the base, it is smooth for  $\frac{1}{5}$ – $\frac{1}{3}$  the entire ray-length; then it commences to thicken as the rhachis and to send out obliquely upwards and outwards a number of elongate-conical scale-like spines. The conically pointed apex of the rhachis projects more or less at the tip as the central conus. The development of the entire ray is subject to a not inconsiderable variation according to individuals, as may be seen by comparing figs. 4 and 5 which are taken from two different specimens. In a certain specimen, the ray never exceeded  $100\mu$  in length and  $35\mu$  in greatest breadth, while in another it often reached a length of  $148\mu$  and a breadth of  $40\mu$  with a greater number of lateral spines.—The five remaining rays are all much more slender and taper gradually towards the conically pointed end. A number of rather sparsely set conical microtubercles

roughen the surface for the outer  $\frac{2}{3}$  or  $\frac{3}{4}$  of their length. They are 75–100  $\mu$  long, the proximal ray being generally somewhat shorter than the paratangentials in the same spicule. Sections through the wall show that, where the dermalia are superposed upon the hypodermalia, the paratangentials of both are not in direct contact, but there intervenes a space which is nearly as wide as the length of the dermal proximal rays (see fig. 22).

The *gastralia* (figs. 7 and 8) are likewise hexactinic pinules. As compared with the dermalia in the same specimen, they show a general agreement in shape and arrangement but are distinguished by an appreciably weaker development of all the rays. This concerns not so much the length as the thickness of these. The pinular ray, besides being thinner, has spines somewhat smaller in size and less in number. It does not exceed 33  $\mu$  in the broadest part.

The above gastral pinules are replaced on the wall of excurrent canals by a less differentiated kind of hexactins, the oxyhexactinic *canalaria* (fig. 9). These present about the same axial length as, or are somewhat larger than, the *gastralia*; but the rays are very much thinner. All the six rays are alike in appearance; generally straight but sometimes bent; and sparsely beset with conical microtubercles on the outer half or less of their length. The transition of the *gastralia* into the *canalaria* at the edge of excurrent apertures is rather abrupt; nevertheless, there are not totally wanting in this position certain intermediate forms—such as have a pinular ray in an incipient degree of differentiation—which may be considered as connecting links between the two. On the other hand, as before mentioned, the

canalaria seem also to pass by gradations insensibly into the smaller parenchymal oxyhexactins, there being such forms as stand between the two in respect of both the situation and the characters of rays.—The canalaria occur at places in tolerable abundance, placed side by side in irregular disposition but always with one ray freely projecting into the canalar lumen. At other places they are found only in scattered distribution. The incurrent canals seem to be totally wanting in specialized canalaria of the kind.

The *hexasters* of the species consist of the strobiloplumicome and a peculiar onychaster-like kind of discohexasters, leaving out of account all those which occur but inconstantly or which in their distribution are confined to the stalk.

The *onychaster-like hexasters* (figs. 12–15) occur in the choanosome, not very abundantly but still in moderate frequency. They are slender-rayed and rather small, measuring 68–100  $\mu$  in diameter. Each short principal bears 2 or 3, sometimes 4, widely divergent, nearly straight or slightly bent terminals, which are thickest at base and thin out to a very fine caliber towards the end. They are obsoletely rough-surfaced or nearly smooth. Occasionally the rosette is hemihexactinose (fig. 13). Now the very terminal point of the terminals is without a trace of a disc-like expansion but bears a whorl of 3–6, sometimes only 2, short and exceedingly fine prongs or branchlets, not more than 4  $\mu$  long. Unlike the claws in a true onychaster the terminal branchlets are straight—not recurved—and are directed sometimes nearly transversely, but generally obliquely forwards and outwards, so as to form a strongly divergent fork or umbel (fig. 15). The branchlets easily fall off, and then, as also when they are over-

looked under an insufficient power of the microscope, the hexaster might readily be mistaken for an oxyhexaster.

The *strobiloplumicome* (figs. 10 and 11) is common, sometimes quite abundant, in the subgastral space. In the subdermal region it occurs only occasionally. Diameter, 34–64  $\mu$ . The smaller ones have much finer and more delicate-looking terminals, and probably represent a not fully developed state of the rosette. The knob at the end of principals is hemispherical, and from its convex surface arise the terminals in about four closely set whorls (fig. 11). As usual the terminals of the innermost whorl are the longest and measure about 27  $\mu$  in length; those of the outermost whorl, only about 10  $\mu$ . The small central process at the distal end of the terminal-bearing knob is frequently difficult to see, but seems to be generally present. Exceptionally was I impressed of its being really absent. Under favorable circumstances I have distinctly seen the axial filament go right through the knob into the distal process.

As hexasters of inconstant occurrence I consider the peculiar kind of discohexaster shown in fig. 16. I have discovered it in a limited number in the body of a medium-sized specimen (Sci. Coll. Mus. No. 473, from Outside Okinosé by the Iwado-line, 500 m.) together with the usual hexasters of the species. It has never been met with in any other specimen. In its general appearance and in the character of its terminal discs, the discohexaster in question is not unlike certain others (fig. 17) which occur in the stalk; but the remarkable difference consists in the fact that either all or some of the terminals split into disc-bearing branchlets [at a point near the outer end. Diameter, 42  $\mu$  and under. Terminals, 3–4 to each short principal, rough-surfaced. Branchlets, 2–5 to a terminal in an umbel-like tuft; their length

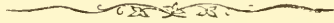
is not uniform in the same hexaster but reaches up to  $15\mu$ . Terminal disc, small, either rudimentary or convex with five, distinct, marginal teeth.

It now remains to consider the spiculation of the *stalk*, As usual it is only the parenchymalia of this part of the sponge that are synaptically fused together. The thicker beams of the rigid framework thus formed are beset with small prickles on the surface. Superiorly in the stalk the ankylosis becomes confined to the axial portion and finally ceases to exist before the body proper is reached.

In the upper part of the stalk the dermalia and the hypodermalia exhibit essentially the same characters as on the body; only they are both more closely set together. Towards the basal end, the dermalia change their character very considerably (fig. 6). They are here small regular hexactins in which all the six rays, being beset all over with nearly vertically outstanding prickles, are alike in appearance; they can not therefore be called pinules.

Besides the usual onychaster-like hexaster and the strobiloplumicome, there occur with tolerable frequency in the stalk certain discohexasters which seem to be peculiar to it (figs. 17-19). These vary considerably in size and general appearance. A large specimen (fig. 17) of them may have a diameter of  $90\mu$ . Each short principal is supplied with 2 or 3, sometimes 4, rough-surfaced, diverging terminals, which perceptibly thicken towards the small, convex, terminal disc with 5, recurved, marginal teeth. Smaller specimens (figs. 18 and 19) of the same may be so small as to measure only  $30\mu$  in diameter. While diminishing in size, the terminals become more slender in caliber while the number

of them (4-8) to each principal increases. The minute terminal disc may be marginally toothed or simply pinhead-like. Transitional forms of the above discohexasters leading into the onychaster-like hexasters have not been discovered.



### **DIAGNOSES OF THE FAMILIES, GENERA AND SPECIES TREATED OF IN THIS CONTRIBUTION.**

By way of a summary and conclusion, I reproduce here the definitions I have given to the families and genera treated of in this Contribution, also giving in proper places short diagnoses of the species described.

#### **EUPLECTELLIDÆ.**

Lyssacine Hexasterophora of tubular, cup-like or massive body; sometimes stalked; either rooted by a tuft of basal spicules or firmly attached by compact base; generally possessing numerous separate oscula. Dermal skeleton composed of hexactinic dermalia, the proximal ray of which is as a rule much longer than any other in the same spicule; no hypodermal pentactins. Hexasters various.

For a list of the genera referable to the family, see p. 20.



The family I divide into two subfamilies, viz.:

1. *Euplectellinæ*. Euplectellidæ rooted in the substratum by a tuft of basal spicules.

2. *Corbitellinæ*. Euplectellidæ firmly attached to the substratum by a compact base.

To the latter belongs

### PLACOSOMA NOV. GEN.

With one species.

*Placosoma paradietum*, n. g., n. sp.—Corbitellinæ with laterally compressed, massively developed, soft body and moderately long, firm stalk. On top, a comparatively small primary osculum leading into the shallow gastral cavity. One side (the front) of the body is covered with a regularly quadrate-meshed, dermal latticework which is supported on another latticework composed of hypodermal fibrous bundles; the other side (the back) presents a more dense-looking surface in which open a large number of secondary oscula leading into the excurrent canal-system. Parenchymalia, principally diactins and occasionally hexactins. In certain positions on the front the dermalia may have the proximal ray so reduced in length as to be not longer than the short distal ray. Gastralia, hexactins. Hexasters in three varieties: the hexactinose discohexaster (30–60  $\mu$  dia.), smallest and most numerous; the spherical discohexaster (160–240  $\mu$  dia.), large and extremely beautiful, confined to the back side of the sponge; and the hexactinose codonhexaster (110–176  $\mu$  dia.) found under the gastral layer. Floricome and graphiocome, not present.

## LEUCOPSACIDÆ IJ. N. FAM.

Lyssacine Hexasterophora of thick-walled, cup-like or ovoid body; sometimes stalked; firmly attached by base (? or rooted by basal spicules). Dermal skeleton composed as a rule of moderately large pentactins with the unpaired ray directed proximad; hypodermalia not distinguishable. Hexasters represented mainly by discohexasters (no oxyhexaster).

A key to the genera and species of this new family is found on p. 33.

## LEUCOPSACUS IJ.

Leucopsacids with small, ovoid or spindle-like body, which may be stalked. Parenchymalia chiefly hexactins; diactinic parenchymalia present, but play a subordinate part. Gastralria represented by hexactins similar to those of the parenchyma. Discohexasters in part hexactinose and in part hexasterous.

*Leucopsacus orthodocus* IJ.—*Leucopsacus* with the inferior end of body narrowed into a stalk. Parenchymal hexactins regular and straight-rayed; forming an approximately regularly quadrate-meshed framework. Besides hexactinose discohexasters (110–168  $\mu$  axial length), there occur smaller hexasterous forms (60–75  $\mu$  dia.) in which the terminals to each principal form a distinct bell-shaped tuft.

*Leucopsacus scoliidocus* IJ.—*Leucopsacus* without a long

stalk. Parenchymal hexactins with curved rays. The hexasterous discohexaster ( $46-70\ \mu$  dia.), present besides the hexactinose form ( $100-180\ \mu$  axial length), is spherical in shape. Of inconstant occurrence is the small and delicate tylloricome.

### CHAUNOPLECTELLA IJ.

Leucopsacids with moderately large, ovoid or vase-like and thick-walled body, attached by short stalk-like base. Parenchymalia chiefly hexactins and diactins. Dermalia either all pentactinic or with a variable number of rays, none of which however are distally outstanding. Gastralia represented by hexactins similar to those of the parenchyma. Discohexasters always hexasterous, the larger ones with terminal prongs arranged in a whorl like anchor-arms; with or without sigmatocome in addition.

*Chaunoplectella cavernosa* IJ.—*Chaunoplectella* of moderately large size; sometimes laterally compressed; with wide canals and subdermal space. In young and small specimens the dermalia and parenchymalia are as in *Leucopsacus*; but in the larger ones both consist of irregular spicules with a varying number of rays, though the dermalia never show a freely outstanding distal ray. Discohexasters of varying size and appearance; when fully developed, they may attain a diameter of  $250-400\ \mu$ , and then have the terminal whorl of reverted prongs shaped like a bell expanding towards the rim. Small delicate sigmatocome present in addition to the above.

*Chaunoplectella spinifera* n. sp.—*Chaunoplectella* of ovoid

body. Dermalia and parenchymalia as in *Leucopsacus*; the former consisting of oxypentactins and the latter, mostly of oxyhexactins. Some, but not all, dermalia with bent spines along the outer side of paratangentials. Discohexasters of varying size and appearance, but not larger than  $114\mu$  diameter. Sigmatocome not found.

#### CAULOPHACIDÆ IJ. N. FAM.

Lyssacine Hexasterophora of cup-like or mushroom-like body; always stalked and firmly attached at base; solitary or forming a small branched colony by budding. Dermal skeleton composed of a layer of small hexactinic or pentactinic pinular dermalia and of large pentactinic hypodermalia. Hexasters represented mainly by discohexasters, either alone or in association with strobiloplumicome.

The family comprises two genera, *Caulophacus* and *Sympagella*.

#### CAULOPHACUS F. E. SCH.

Caulophacids of cup-like or fungiform body; solitary (always?). Parenchymalia chiefly diactins but including also large regular hexactins. Dermalia, hexactinic pinules; on the stalk these may be replaced by pentactinic forms. Gastralialia, either hexactinic or pentactinic pinules. Discohexaster present in varying forms. Without strobiloplumicome.

A key to all the species, at present known, of this genus is given on p. 86.

*Caulophacus lotifolium* n. sp.—*Caulophacus* with inverted-conical body, continued below into a long stalk. Dermalia and gastralia, hexactinic; the former with a spindle-shaped, and the latter with a slender, elongate, pinular ray. On the lower part of the stalk the dermalia lose the proximal ray, while the distal ray assumes a club-like or balloon-like shape. Spherical discohexasters (60–115  $\mu$  dia.) with thick, barbed terminals; sometimes hemihexactinose or hexactinose; they lead by gradual transition into much thinner-rayed, onychaster-like forms. Without lophodiscohexaster.

#### SYMPAGELLA O. SCHM.

Caulophacids of cup-like body, showing tendency to form small colony by budding. Parenchymalia as in *Caulophacus*. Dermalia, either hexactinic or pentaactinic pinules. Gastralia, hexactinic pinules. Besides discohexasters, strobiloplumicome always present.

For a key to species referred to this genus, see p. 97.

*Sympagella anomata* n. sp.—*Sympagella* with irregularly-shaped body, composed of a small number of incompletely divided persons in each of which an osculum opens at the upper end; stalk multiple, or branched and anastomosing. Both dermalia and gastralia, hexactinic; similarly developed, though the former is much stouter; pinular ray, spindle-like. Discohexaster, mainly an onychaster-like form (up to 100  $\mu$  dia.) in which the terminals are finely attenuated towards the end and bear at the point 2–6, short and exceedingly fine branchlets in forwardly and outwardly directed (not retroverted) arrangement. Strobiloplumicome of the usual shape and structure.

## ROSSELLIDÆ.

Lyssacine hexasterophora of cup-like or sacciform body; sometimes stalked; generally firmly attached at base and exceptionally rooted by tufts of basal spicules. A few secondarily formed oscula may occur besides the main terminal osculum. Dermal skeleton composed of small dermalia with a variable number of rays and of large hypodermalia. The latter are generally pentactins which often show a tendency to protrude outwards in such a way that the paratangentials form a veil-like covering over the dermal surface. The dermalia, when hexactinic, have the distal ray not pinular but much like the rest in appearance. The hexasters are various but mainly oxyhexasters and discohexasters, these generally occurring together; but sometimes one kind occurs to the exclusion of the other. Oxyhexasters are often hemihexactinose and hexactinose. Discohexasters frequently modified into discoctasters.

Though this family has not formed a subject for treatment in the present Contribution, the diagnosis is here given for the sake of comparison with those of other lyssacine hexasterophorous families.





### Postscript I.

At a time when the printing of this memoir was nearly finished I received A. SCHRAMMEN's paper "Zur Systematik der Kiesel-spongien" (Mitth. Roemer-Museum. No. 19. Hildesheim 1903). This contains an emendation of the Hexactinellidan system advanced by the same writer in '02 and to which I have had occasion to refer critically in the foot-note on pp. 23-25 of this Contribution. It is satisfactory to observe that SCHRAMMEN's new system shows a great approach to that which I have in my mind and of which I have made a brief exposition in the foot-note just mentioned, though it still differs from mine in an important point, as will presently be pointed out.

SCHRAMMEN accepts F. E. SCHULZE's Amphidiscophora and Hexasterophora as the two suborders of the order Hexactinellida, while the little known palaeozoic forms formerly put together by him under a distinct suborder, the Stauractinophora, are placed in an appendix under the families *incertae sedis*. This is, I think, quite in accordance with the present stage of our knowledge about the sponges in question. The Hexasterophora are divided by him into two tribes, the Hexactinosa and the Lychniscosa; the former defined as "Hexasterophora, deren Stützgerüst aus Hexactinen besteht" and the latter as "Hexasterophora, deren Stützgerüst aus Lychnisken besteht." It is decidedly an advance that the lychniscophorous forms (the Lychniscosa) are brought under the Hexasterophora, which they certainly are. The tribe Hexactinosa SCHR. is made to comprise three subtribes, the Uncinataria, the Inermia and the Euplectellaria. Of these, the

first and the last exactly correspond in scope, each to each, to two of the three Hexasterophora tribes in my system which I have provisionally designated with the first three letters of the alphabet (p. 25, *l. c.*), namely, to the tribes C and A respectively. On the other hand, SCHRAMMEN's Inermia differs from the tribe B of my system in that all the lychniscophorous forms (which, as above mentioned, are made by him into the Lychniscosa) are excluded from it; whereas I place them under the tribe B, together with, but as representing a family or families distinct from, the Dactylocalycidæ (*Dactylocalyx*, *Myliusia*, etc.). This is the point in which I stand in disagreement with SCHRAMMEN, —a disagreement which I am strongly inclined to regard as due to an over-estimation, on his part, of the lychnisc as a systematic character.

The diagnoses of the Hexactinosa and the Lychniscosa, as given by SCHRAMMEN and cited above, appear to me as wholly inadequate to characterize the groups. The Hexactinosa is stated to have the supporting framework composed of *hexactins*. This may be said to hold good for the dictyonine forms of that group but not for all: a mere reference to the parenchymalia in the Euplectellaria is sufficient. Be that as it may, the lychnisc, which should characterize the Lychniscosa as opposed to the Hexactinosa, is, fundamentally, likewise a hexactin or a part of a hexactin; it is clearly a secondary structure or complication which has for its basis hexactins, such as compose an ordinary dictyonal skeleton (see MARSHALL u. MAYER, Mitth. kgl. Zool. Mus. Dresden, 1877, p. 267; F. E. SCHULZE, Hexactinelliden des Rothen Meeres, 1900). Therefore, the supporting framework of the Lychniscosa is, in my way of thinking, as really composed of hexactins as that of certain Hexactinosa. The lychnisc as a

systematic character can only be utilized to characterize a group standing subsidiary to another and more comprehensive group in which the supporting skeletal framework consists of hexactins,—of dictyonally fused hexactins, I may add. Thus, the Hexactinosa and the Lychniscosa, as defined and placed in the system by SCHRAMMEN, seem to lose all ground for existence and may be entirely dispensed with.

On the other hand, if it be justifiable, as I believe it is, to consider *Aulocystis* as the living representative of all the lychniscophorous Hexactinellids that have existed, there can be no tangible reason for not receiving these into the group Inermia. F. E. SCHULZE (Chall. Rep.) placed *Aulocystis* in the same inermate family (Mæandrospongidae) with *Dactylocalyx*, *Myliusia* etc., and there was a time when it even passed under the name of *Myliusia*. While I do not follow F. E. SCHULZE's opinion as to the family to which *Aulocystis* should belong, I can not but agree with him in regarding it as one of the Inermia. Granted this point, the three subtribes SCHRAMMEN's may be called the tribes—exactly the same as those in my system—into which the suborder Hexasterophora may be directly divided.

It may here be noted that the division I have adopted of the Hexactinellida into the suborders, tribes and subtribes is in complete agreement with F. E. SCHULZE's idea of the Hexactinellid phylogeny as ably enunciated by him in the end of the Challenger Report. If graphically represented, so far as it goes would take essentially the same appearance as the genealogical tree given by that author *l. c.* page 495.

Tokyo, April 5th, 1903.

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### Postscript II.

Following SCHRAMMEN'S paper above referred to, I have received, just in time to add this postscript, F. E. SCHULZE'S latest Hexactinellid work in which *Caulophacus arcticus* (A. HANSEN) and *Calycosoma gracile* F. E. SCH. nov. spec. are described in detail (Abh. kgl. preuss. Akad. Wiss. 1903).

With *Caulophacus arcticus*, which comes from a depth of 1977 m. in the Northeast Atlantic, a sixth species is added to the five I have enumerated in this Contribution. As pointed out by F. E. SCHULZE, it shows in the spiculation an extensive agreement with, and therefore seems to be most closely related to, *C. latus* of the South Indian Ocean. So far as can be made out with certainty from the descriptions and figures relating to both, the following seem to be the most important features that characterize *C. arcticus* as distinct from *C. latus*: 1. The pinular ray of the dermalia is narrower and pointed at the apex, being thus spindle-like instead of ovoid.\* 2. The slender pinular ray of the gastralial is shorter by one-half or more, measuring 250–500  $\mu$  in length as against 1 mm. or more of *C. latus*. 3. The occasional presence of hemihexactinose pachydiscohexasters in addition to hexactinose forms.† 4. The tufts of terminals to

\* In the Chall. Report (p. 125) the dermal pinular ray in *C. latus* is stated to be usually 50  $\mu$  long; but this scarcely accords with the size of its figure as given *l. c.* Pl. XXIV., fig. 10, magnified 100 times. One is led to suspect a typographical error or errors in this connection; but if it be that the scale of magnification appended is correct, the dermalia of *C. latus* must be said to have the pinular ray strikingly larger than that of the same spicule in *C. arcticus*,—a fact which might conveniently be made use of as one of the differential points between the two species.

† F. E. SCHULZE (*l. c.* p. 8–11) disapproves of applying the term hexaster to the quasi-hexactin called by me the hexactinose hexaster. Grounds for my persisting to use this appellation and the advantage to be derived therefrom, will be dealt with in another publication.

lophodiscohexasters are considerably broader, they being of a narrowly conical shape in *C. latus*. The last point is considered by F. E. SCHULZE to constitute the chief difference between the two species. I have gone into the comparison somewhat more critically than F. E. SCHULZE did, simply in order to contrast them, as far as possible, with respect to the points utilized by me for distinguishing *C. latus* in the key given on p. 86 of this Contribution. The diagnosis of the genus (p. 85) is in no way affected by the addition of the sixth species.

As regards *Calycosoma gracile* F. E. SCH., I regret, with due deference to the judgment of so high an authority as its describer, that I can not readily accept the generic denomination given to it. In studying its characters as embodied in the description, one will at once be struck with the close resemblance to my *Sympagella anomala* in all points of the organization. In fact, I can scarcely discern in it any noteworthy difference from *S. anomala* beyond the facts that parenchymal oxyhexactins (up to 1.5 mm. axial length) and oxydiaetins (3–5 mm. long and 60–100  $\mu$  broad) are much more strongly developed and that there occur oxyhexasters in addition to the onychaster and the strobiloplumicome. It is possible that the two forms in question may in the future be proved to be specifically identical and that the differences mentioned may be found to be simply matters of individuality; but for the present they may on the ground of those differences be allowed to stand as two very closely related species. Be this as it may, it seems certain that they can not possibly belong to different genera. Either my *Sympagella anomala* is to be re-christened as *Calycosoma anomalum*, or *Calycosoma gracile* as *Sympagella gracilis*; while a further possibility is that they may have to be put into a third genus, in which case



*Aulascus* (supposing this to be tenable as a genus distinct from *Sympagella*), as being the nearest to both, comes in question, since the creation of a new genus for their reception is scarcely to be thought of. The question whether *Calycosoma* should be amalgamated with either *Aulascus* or *Sympagella*, or with both together, seems to be uncalled for at present.

I completely concur with F. E. SCHULZE (*l. c.*, p. 20; *vide* also my Contrib. I., p. 55) in regarding the onychaster and the oxyhexaster as two hexaster-forms of comparatively trivial difference. At the same time it will be conceded by all that the onychaster is to be considered as a discohexaster with the terminal disc in the most rudimentary state of development, being in fact represented by a whorl of fine claw-like branches. Now in *Aulascus* (*A. johnstoni*) the hexasters in question are all discohexasters, in which the terminal whorl of prongs is by no means strongly developed and many of which indeed present a resemblance to typical onychasters (F. E. SCH., '97, p. 527). On the other hand, *Calycosoma* (as represented by the single species *C. validum*) has the corresponding hexaster represented solely by oxyhexasters; it is of no moment that some of these are in the hexactinose form. Now the new species *C. gracile* shows the same hexaster partly in the form of oxyhexasters and partly in onychaster-like forms; so that it may be said that in this respect it stands midway between *Aulascus* and *Calycosoma*. It merges into the former through the onychaster-like hexaster and into the latter through the oxyhexaster. Recourse must then be taken to some other differential indications than the hexaster in order to decide to which of the two genera the new species is more closely allied. So far as the spiculation goes, a point that can be utilized as such an index seems to be found in the dermalia and the gastralialia.



These agree almost completely with those of *A. johnstoni* in general appearance but especially in the character of the pinular ray; whereas, they, as compared with the same of *C. validum*, present (to use F. E. SCHULZE's words) "eine auffällige Differenz" in the development of the lateral spines. It is clear what this points to. Perhaps another not unimportant difference in the spiculation is the presence in *C. validum* of proctal needles in tufts, which are totally wanting in the new species as well as in *A. johnstoni*. Further taking into our consideration the occurrence in the new species of bud-like prominences on the wall which may lead to the formation of such incompletely individualized persons as are known in *Aulascus*, and of a distinct, branched stalk known to be common in the nearest allies of that genus, I can but think the evidence is decidedly in favor of considering the new species to be nearer to *A. johnstoni* than to *Calycosoma validum*. If the two genera are to be kept separate, it should rather be placed under *Aulascus*. But since I hold this genus as unitable with *Sympagella* (p. 96), I should accept F. E. SCHULZE's new species into my system under the name of *Sympagella gracilis* (F. E. SCH.).

With this change, the diagnosis of the genus *Sympagella* as given by me in this Contribution (pp. 96, 113) requires alteration only in so far as the oxyhexaster should not now be excluded from among the hexasters of the genus. The passage concerning these should be made to read "*Besides discohexasters, which are sometimes accompanied with oxyhexasters, plumicomae are always present.*" The family diagnosis given on pp. 84 and 112 may remain as it is.

There is no denying the fact that *Sympagella gracilis* brings the Caulophacids (*Caulophacus* and *Sympagella*), whether as a

distinct family as I have made them or as a group taken over into the Rossellidæ, into direct touch with the Lanuginellinæ, the contact point on the part of this Rossellid subfamily being found in *Calycosoma validum*. And whether or not this genus and species should be joined to the rank of the Caulophacids, now appears to be largely a matter of individual opinion.

Tokyo, April 15th, 1903.

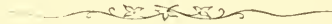


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I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

PLATE I.

*Placosoma paradietium*, n. g.; n. sp.

**Plate I.**

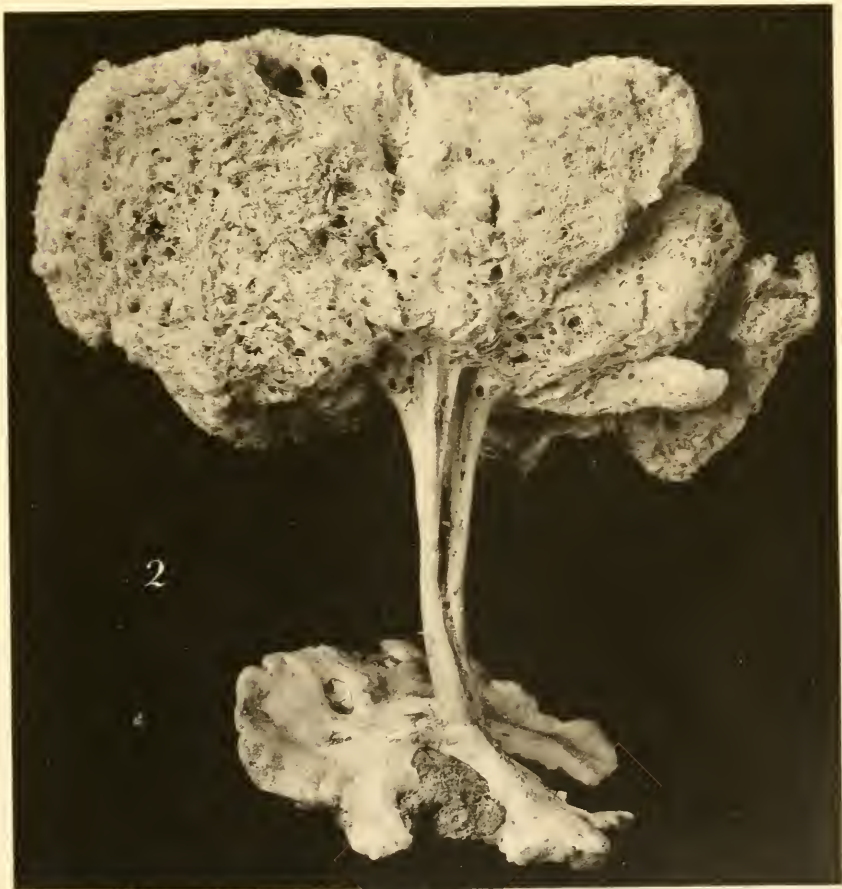
*Placosoma paradictyum* Is. Pp. 2-19.

Fig. 1. The type-specimen, seen from the front side. (Sci. Coll. Mus. Sp. No. 506).

Fig. 2. Same, seen from the back side.

Both figures reduced to a size slightly smaller than half natural size.





*Placosoma paradietium* Ij.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

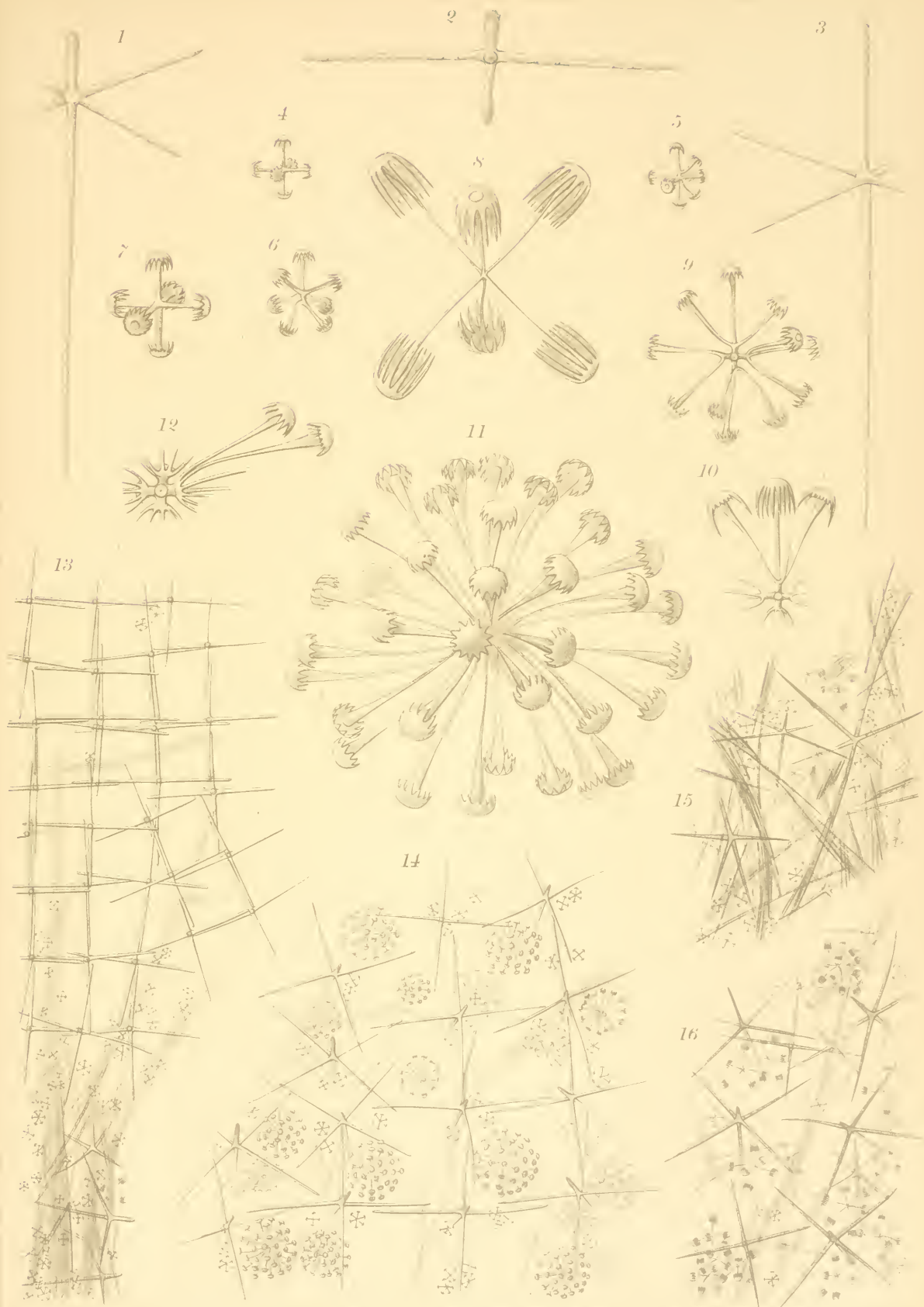
PLATE II.

*Placosoma paradietyum*, N. G.; N. SP.

## Plate II.

*Placosoma paradictyum* L. Pp. 2-19.

- Fig. 1. A dermalia from the frontal lattice, with greatly elongated proximal ray. 150  $\times$ .
- Fig. 2. A dermalia from the frontal lattice, with short proximal ray. Lateral view. 150  $\times$ .
- Fig. 3. A gastralia from the gastral cavity inside the primary or main osculum. 150  $\times$ .
- Fig. 4. A medium-sized hexactinose discohexaster from a hypodermal beam of the frontal lattice. 200  $\times$ .
- Figs. 5, 6. Hemihexactinose discohexasters of occasional occurrence. From the back side of the sponge. 300  $\times$ .
- Fig. 7. A large hexactinose discohexaster, from the same side. 300  $\times$ .
- Fig. 8. A hexactinose codonhexaster from the main gastral surface. 300  $\times$ .
- Fig. 9. A normally developed discohexaster, occasionally found together with the large spherical form of fig. 11. From the back side. 300  $\times$ .
- Fig. 10. Another occasional form of discohexaster (codonhexaster) from the same side. 300  $\times$ .
- Fig. 11. A large, spherical discohexaster from the same side. 300  $\times$ .
- Fig. 12. A portion of the same, showing the central parts. 300  $\times$ .
- Fig. 13. A small portion of the frontal lattice. Above, the dermal latticework. Below, the hypodermal beam. 50  $\times$ .
- Fig. 14. Dermal surface of the back. 50  $\times$ .
- Fig. 15. A small portion of septum from the choanosome. 50  $\times$ .
- Fig. 16. Surface of the main gastral cavity. 50  $\times$ .



*Placosoma paradietum* Ij.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

PLATE III.

*Leucopsacus orthodocus* Ij.

*Leucopsacus scoliodocus* Ij.

This plate also contains figures (1-13) taken from two small specimens of *Staurocalyptus* sp., not specifically determinable with certainty on account of their young state. Both are from the Sagami Sea. References to these figures will be made in a future Contribution relating to the Rossellidae.

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Figs. 1-6. Young *Staurocalyptus* sp. (Sci. Coll. Mus. Sp. No. 437).

Fig. 1. Spicules of dermal surface, seen from outside. 100  $\times$ .

Fig. 2. Spicules of gastral surface, seen from inside. 100  $\times$ .

Figs. 3, 4. Common oxyhexasters. 300  $\times$ .

Fig. 5. Microdiscohexaster. 300  $\times$ .

Fig. 6. Portion of a discoctaster. 300  $\times$ .

Figs. 7-13. Young *Staurocalyptus* sp.

Fig. 7. Surface-view of dermal layer. 30  $\times$ .

Fig. 8. Combination figure of spiculation of the wall. 30  $\times$ .

Fig. 9. Entire specimen. 2  $\times$ .

Fig. 10, 11. Deformed discoctasters. 300  $\times$ .

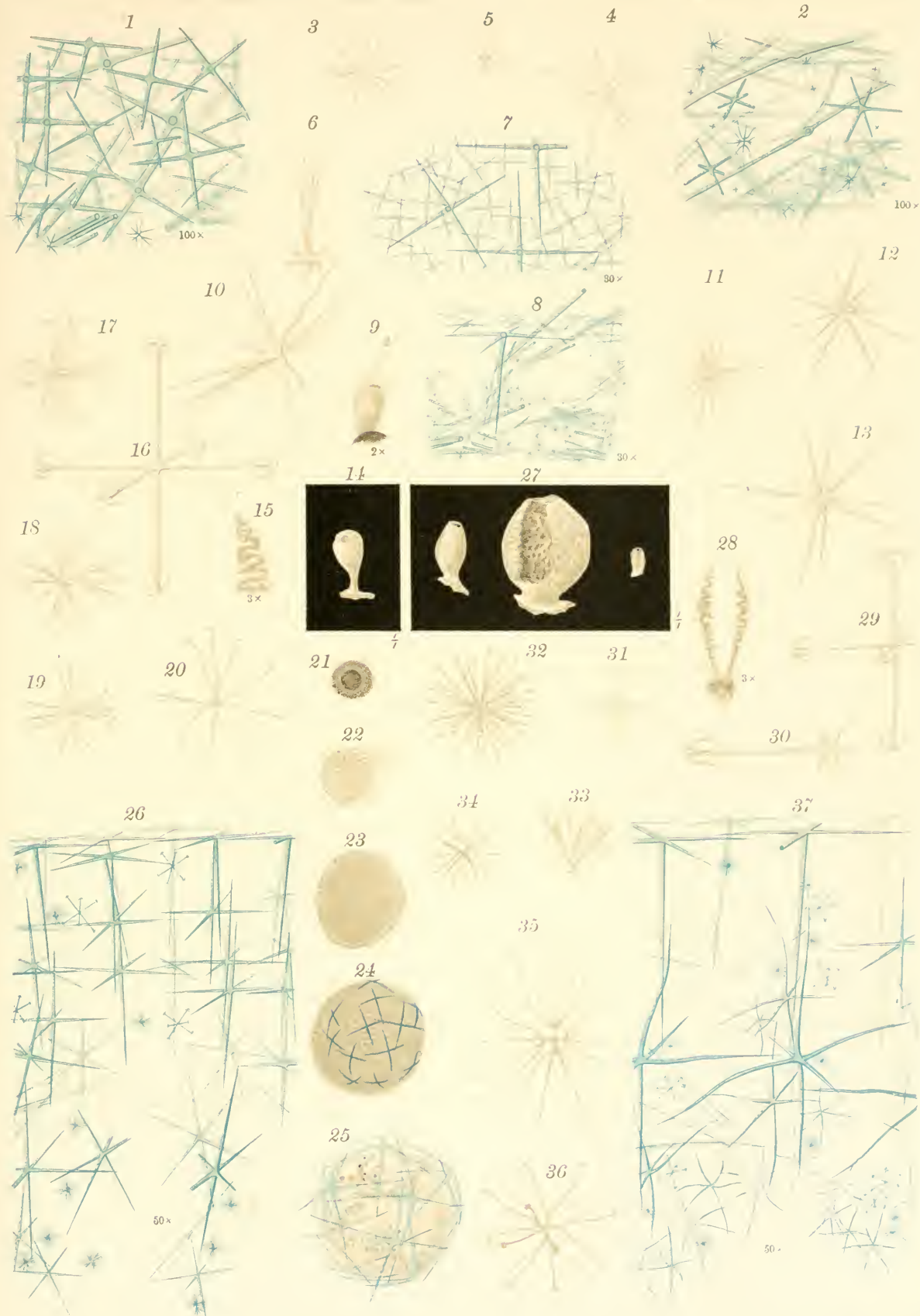
Fig. 12, 13. Oxyhexasters. 300  $\times$ .

Figs. 14-26. *Leucopsacus orthodocus* L. Pp. 34-46.

- Fig. 14. One of the type specimens (Sci. Coll. Mus. Sp. No. 230). Nat. size.  
Fig. 15. Longitudinal section of wall stained; above, the oscular edge. (Sci. Coll. Mus. Sp. No. 438).  $3\times$ .  
Fig. 16. Hexactinose discohexaster of an average size.  $300\times$ . From Sp. No. 230.  
Fig. 17. Hexasterous discohexaster, from the same specimen.  $300\times$ .  
Fig. 18-20. Same, from Sp. No. 438. Fig. 20 represents an occasional form.  $300\times$ .  
Fig. 21. Egg-like cell of doubtful origin and nature, found in Sp. No. 230.  $300\times$ .  
Fig. 22. A moderately large-sized archæocyte-congeries, drawn from a section. The spherules represent nuclei.  $300\times$ .  
Fig. 23. Larva in an early development stage, yet without spicules. Seen in optical section.  $300\times$ .  
Fig. 24. Older larva of about  $70\mu$  diameter; in optical section, but all the spicules in a hemisphere, seen by different foci of the microscope, are drawn in. Histological elements in the central part a little too distinctly shown.  $300\times$ .  
Fig. 25. Oldest larva observed; all the spicules of the upper hemisphere drawn in.  $300\times$ .  
Fig. 26. Combination of sections to show spiculation of wall. Above, the dermal; below, the gastral, surface. About  $50\times$ .

Figs. 27-37. *Leucopsacus scoliodocus* L. Pp. 46-52.

- Fig. 27. Type specimens. The largest in the middle is Sci. Coll. Mus. Sp. No. 233; the two others are from Sp. No. 235. Nat. size.  
Fig. 28. Stained longitudinal section of an entire specimen. Basidictyonal mass at base.  $3\times$ .  
Fig. 29. Hexactinose discohexaster.  $300\times$ .  
Fig. 30. Portion of same, showing the extent of axial threads in the central node.  
Fig. 31. Delicate tyloffloricome of inconstant occurrence, from Sp. No. 434.  $300\times$ .  
Fig. 32. Spherical discohexaster, from Sp. No. 233.  $300\times$ .  
Fig. 33. Portion of same, showing the short principal.  
Fig. 34. Small form of spherical discohexaster, from Sp. No. 235.  $300\times$ .  
Fig. 35. Unusually large discohexaster, occasionally met with. From Sp. No. 233.  $300\times$ .  
Fig. 36. Rare form of discohexaster. From Sp. No. 235.  $300\times$ .  
Fig. 37. Combination of sections to show spiculation of wall. Above, the dermal; below, the gastral surface. About  $50\times$ .



1-6. *Staurocalyptus* sp.

14—26. *Leucopsacus orthodocus* IJ.

7—13. *Staurocalyptus* sp.

27—37. *Leucopsacus skolidocus* IJ.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

PLATE IV.

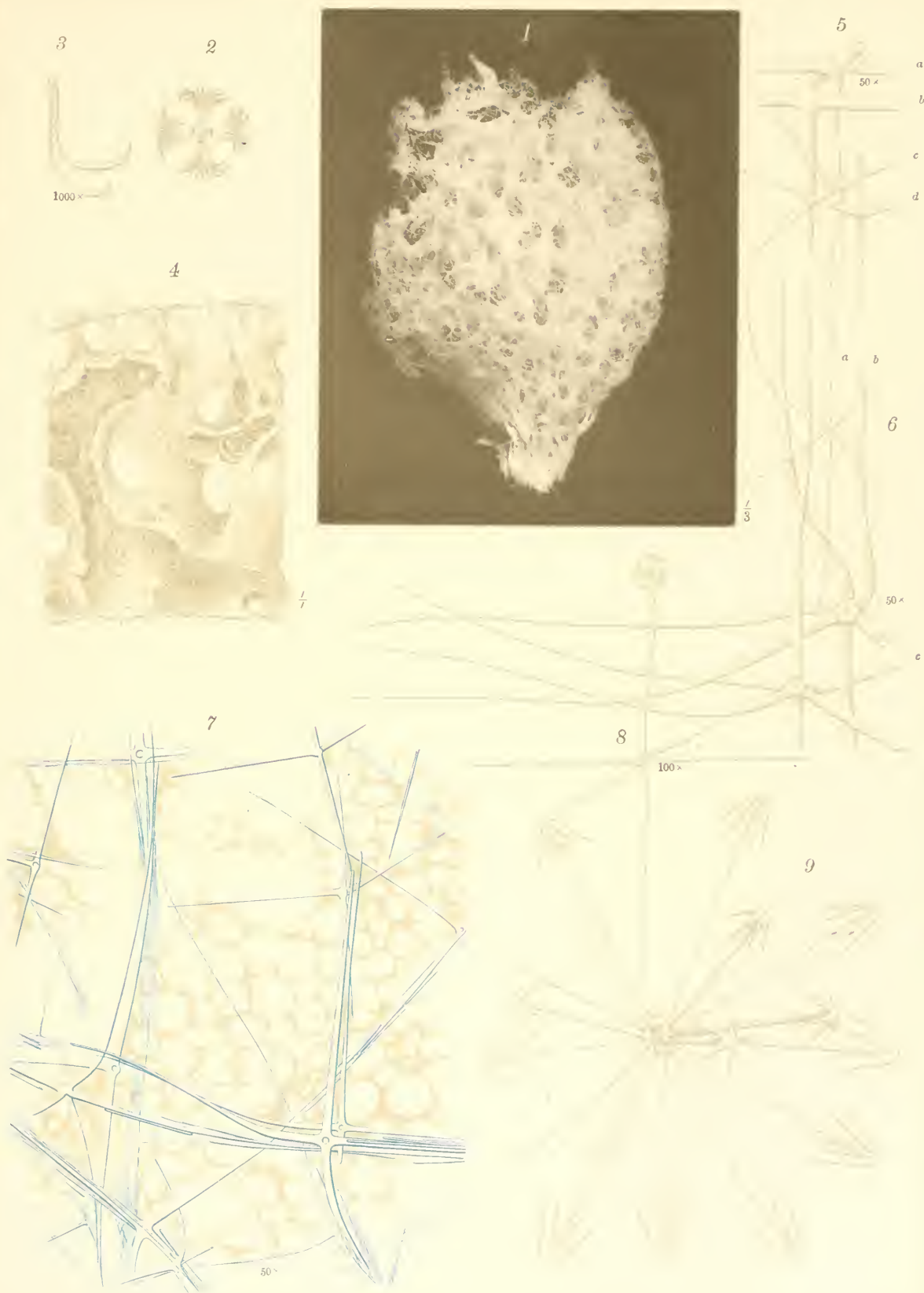
*Chaunoplectella cavernosa* Ij.

## Plate IV.

*Chaunoplectella cavernosa* B. Pp. 53-71.

- Fig. 1. Portion of the wall of a large individual  $\frac{1}{3}$  nat. size. All the figures in this plate taken from this specimen (Sci. Coll. Mus. Sp. No. 443).
- Fig. 2. Sigmatocome.  $300\times$ . Same as fig. 11 of the following Plate.
- Fig. 3. Two terminals from the same. About  $1000\times$ .
- Fig. 4. Section of the wall. About nat. size. Above, the dermal surface. Arrows show the direction of water current.
- Fig. 5. Portions of spicules in the periphery. a, b, pentactinic and tauactinic dermalia. c, d, two unequally rayed parenchymalia. About  $50\times$ .
- Fig. 6. Parenchymal hexactins of different sizes (a, b, c). About  $50\times$ .
- Fig. 7. Dermal layer seen from outside, with soft dermal reticulum.  $50\times$ .
- Fig. 8. Oxyhexactinic canalaria, with a sigmatocome (fig. 2) at the end of the freely projecting ray.  $100\times$ . See fig. 12 of the following Plate.
- Fig. 9. Large discohexaster with anchorate terminal umbels.  $300\times$ .





*Chaunoplectella cavernosa* IJ.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

## PLATE V.

*Lanuginella* pupa O. SCHM.

*Chaunoplectella cavernosa* IJ.

*Chaunoplectella spinifera* IJ.

The figures (1-7) relating to *Lanuginella pupa* will be referred to in a future Contribution.

## Plate V.

Figs. 1-7. *Lanuginella pupa* O. Schm.

Figs. 1-3. Discohexasters from one and the same specimen (Sci. Coll. Mus. Sp. No. 436). 300  $\times$ .

Figs. 4-6. Same from another specimen (Sp. No. 234). 300  $\times$ .

Fig. 7. Portion of a strobiloplasticome. 1000  $\times$ . The short central boss on the terminal-bearing knob at the end of each principal ray has been omitted through oversight.

Figs. 8-13. *Chaunoplectella cavernosa* L. Pp. 53-71.

Figs. 8, 9. Young specimens (Sci. Coll. Mus. Sp. No. 407) of various sizes, attached to a dead *Chonelasma*. Nat. size.

Fig. 10. A dried specimen complete (O. C. No. 4389).  $\frac{1}{2}$  nat. size.

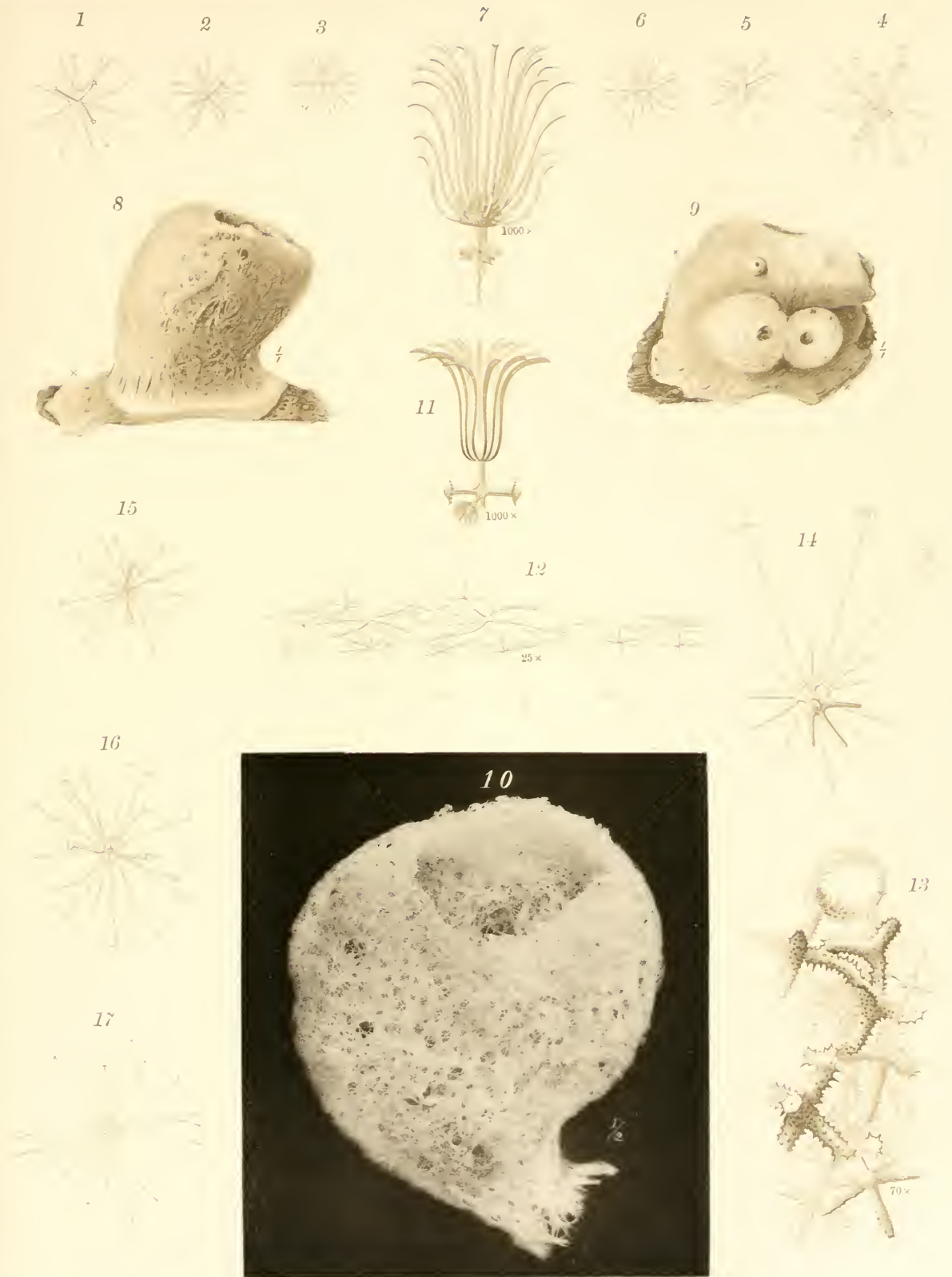
Fig. 11. Sigmatocome. 1000  $\times$ .

Fig. 12. Septal wall in section. Above, the incurrent surface; below, the excurrent surface. Above 25  $\times$ .

Fig. 13. Basidictyonal framework. 70  $\times$ .

Figs. 14-17. *Chaunoplectella spinifera* L. Pp. 71-77.

Figs. 14-17. Different forms of discohexasters found in the specimen (Sci. Coll. Mus. Sp. No. 435). 300  $\times$ .



1-7. *Lanuginella* pupa O.SCHM.

8-13. *Chaunoplectella cavernosa* IJ.

14-17. *Chaunoplectella spinifera* IJ.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

PLATE VI.

*Chaunoplectella spinifera* Ij.

*Staurocalyptus japonicus* Ij.

*Staurocalyptus tubulosus* Ij.

The figures relating to *Staurocalyptus japonicus* and *tubulosus* to be referred to in a future Contribution.

## Plate VI.

Figs. 1-8. *Chaunoplectella spinifera* Lj. Pp. 71-77.

(All figures from Sci. Coll. Mus. Sp. No. 459).

- Fig. 1. The type-specimen. Natural size.
- Fig. 2. Oxyptactinic dermalia with spine-bearing paratangential rays. 100  $\times$ .
- Fig. 3. Spherical form of discohexaster from the periphery of wall. 300  $\times$ .
- Fig. 4. Larger spherical form of discohexaster from deep parts. 300  $\times$ .
- Fig. 5. Discohexaster with terminals in six separate tufts. From deep parts. 300  $\times$ .
- Fig. 6. Discohexaster of similar form but with very slender terminals. From deep parts. 300  $\times$ .
- Fig. 7. Largest form of discohexaster. From deep parts. 300  $\times$ .
- Fig. 8. Combination-figure to show the arrangement of skeletal elements in the periphery of the wall. Above, the dermal layer. 25  $\times$ .

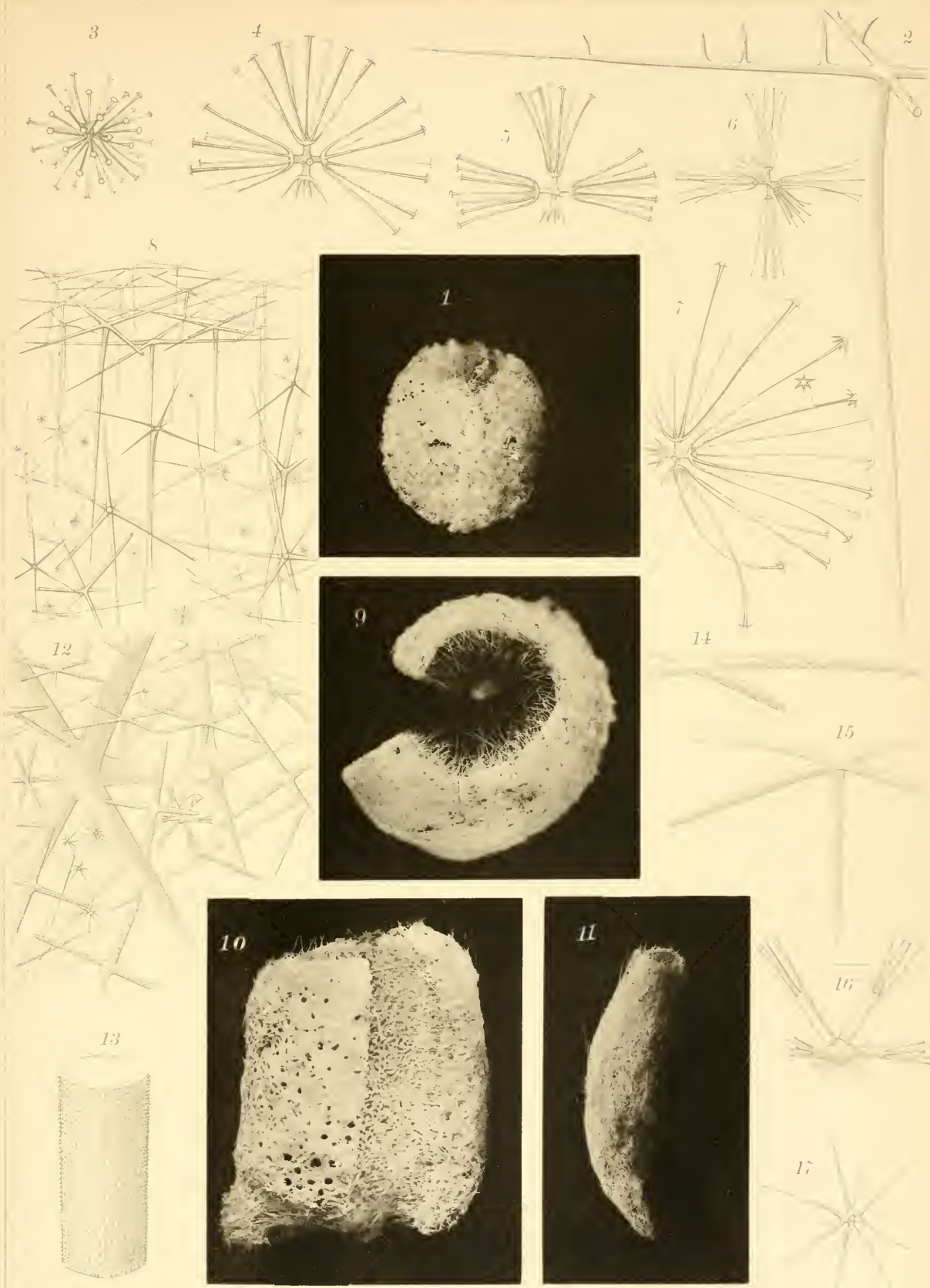
Figs. 9, 10. *Staurocalyptus japonicus* Lj.

- Fig. 9. Sci. Coll. Mus. Sp. No. 403, seen from oscular end. Natural size.
- Fig. 10. Same specimen in lateral view. Natural size.

Figs. 11-17. *Staurocalyptus tubulosus* Lj.

(All figures from Sci. Coll. Mus. Sp. No. 241).

- Fig. 11. The type specimen. Natural size.
- Fig. 12. Dermal layer seen from outside. Several dermalia and two hypodermal pentactins. 100  $\times$ .
- Fig. 13. Portion of a paratangential ray of the proctal or hypodermal pentactin, to show the character of its surface. 300  $\times$ .
- Figs. 14, 15. Stauroactinic and pentactinic dermalia. 300  $\times$ .
- Fig. 16. Discoctaster from dermal side. 300  $\times$ .
- Fig. 17. Oxyhexaster. 300  $\times$ .



1—8. *Chaunoplectella spinifera* Ir.

9—10. *Staurocalypus japonicus* Ir.

11—17. *Staurocalypus tubulosus* Ir.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

PLATE VII.

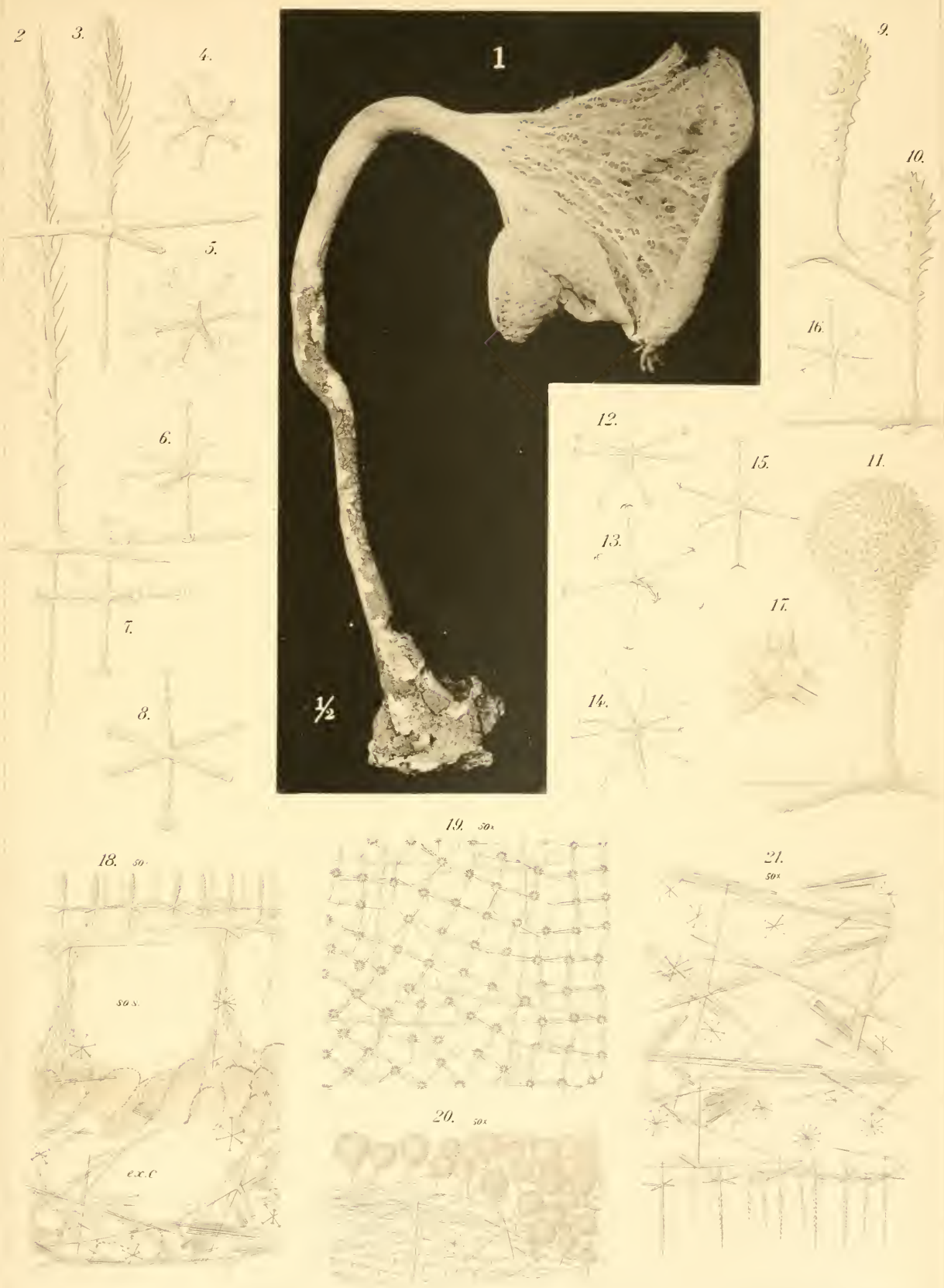
*Caulophacus lotifolium* Ij.

## Plate VII.

*Caulophacus lotifolium* Ix. Pp. 87-96.

- Fig. 1. The type specimen, now preserved in the "Kgl. Naturalien Kabinet" in Stuttgart. About  $\frac{1}{2}$  natural size.
- Fig. 2. Gastral hexactinic pinule of average size. 300  $\times$ .
- Fig. 3. Dermal hexactinic pinule of average size. 300  $\times$ .
- Figs. 4, 5. Normally developed, thick-rayed discohexasters from subdermal or subgastral region. 300  $\times$ .
- Fig. 6. Hemihexactinose form of same. 300  $\times$ .
- Figs. 7, 8. Hexactinose form of same; from deep parts. 300  $\times$ .
- Figs. 9-11. Pentactinic dermalia from the lower part of stalk. 300  $\times$ .
- Figs. 12-16. Slender-rayed discohexasters, which pass over by gradations into the forms of figs. 4-8. Figs. 14-16, onychaster-like. From peripheral region of the sponge. 300  $\times$ .
- Fig. 17. Central part of a hexactinose discohexaster, showing the extent of the axial cross. Observed in glycerine. 1000  $\times$ .
- Fig. 18. Part of a section through the sponge, with soft parts preserved. Above, dermal layer (ectosome). *sd. s.* subdermal space. Below, periphery of choanosome. *ex. c.*, excurrent canal 50  $\times$ .
- Fig. 19. Dermal skeleton, seen surface on. Beneath the dermal latticework, the hypodermal lattice with larger meshes. 50  $\times$ .
- Fig. 20. Surface of the stalk in oblique view. Above, the crowded layer of balloon-shaped pentactinic dermalia. 50  $\times$ .
- Fig. 21. Part of a section, adjoining the gastral surface. Below, gastral layer. 50  $\times$ .





*Canthopacus lotifolium* Ij.

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STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION III.

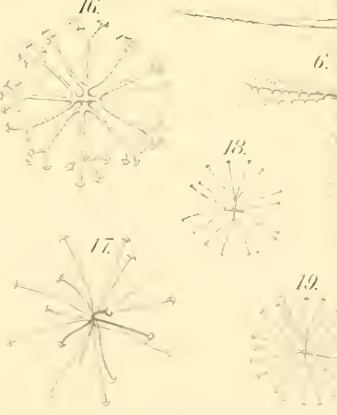
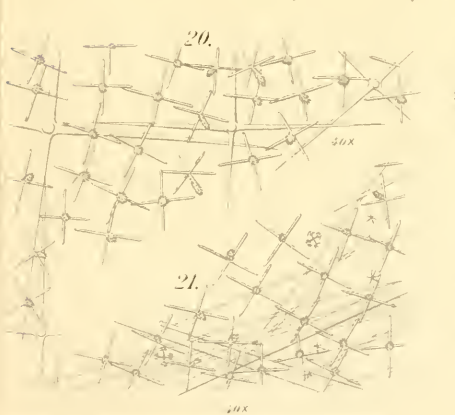
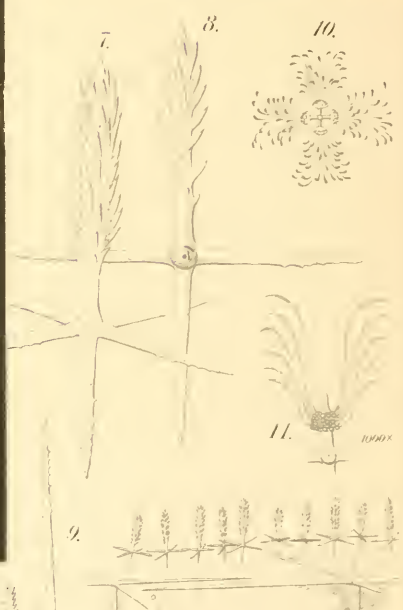
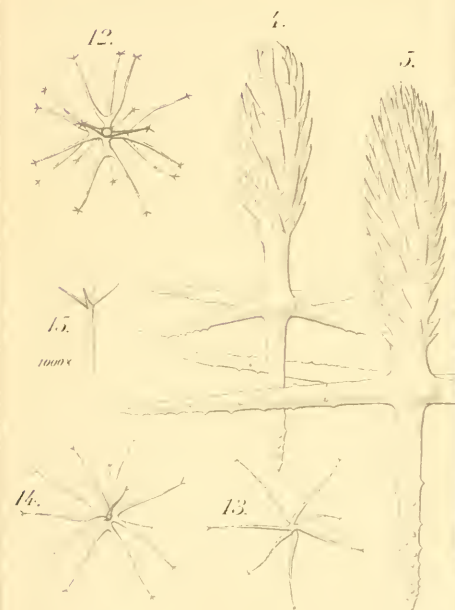
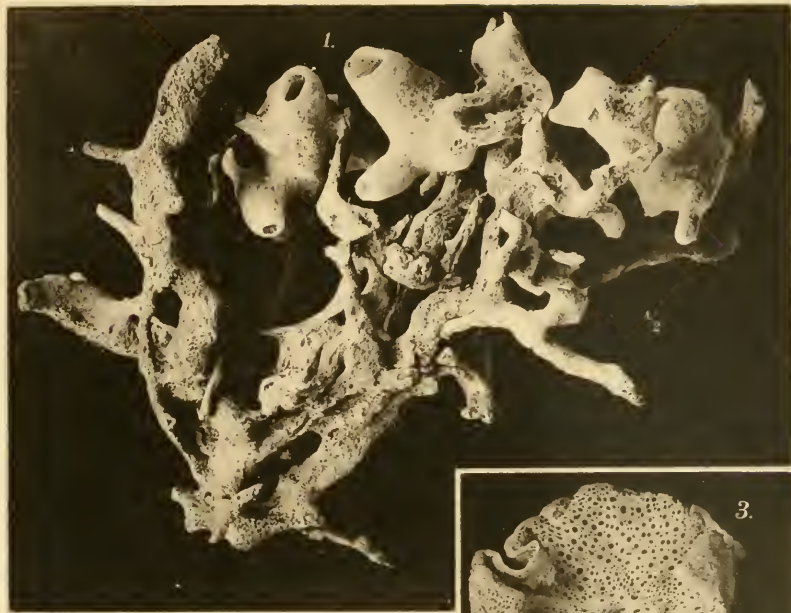
PLATE VIII.

*Sympagella anomala* Ij.

## Plate VIII.

### *Sympagella anomala* J.

- Fig. 1. A number of small and young specimens attached on an old dead stalk of the same species.  $\frac{1}{2}$  nat. size. (Sci. Coll. Mus. Sp. No. 455).
- Fig. 2. A medium-sized specimen, attached to a piece of dead *Chonelasma*.  $\frac{1}{2}$  nat. size. (Sci. Coll. Mus. Sp. No. 367).
- Fig. 3. A large specimen, with a part of the wall removed to show the gastral surface.  $\frac{1}{2}$  nat. size. (Sci. Coll. Mus. Sp. No. 355).
- Figs. 4, 5. Dermalia from different specimens. 300  $\times$ .
- Fig. 6. Modified dermalia from the lower part of stalk. 300  $\times$ .
- Figs. 7, 8. Gastralia from different specimens. 300  $\times$ .
- Fig. 9. Canalaria from excurrent canal. 300  $\times$ .
- Fig. 10. Strobiloplumicome. 300  $\times$ .
- Fig. 11. Part of a strobiloplumicome, partially constructed to show the structure. 1000  $\times$ .
- Figs. 12-14. Onychaster-like hexasters. 300  $\times$ .
- Fig. 15. Outer end of a terminal from an onychaster-like hexaster. 1000  $\times$ .
- Fig. 16. Peculiar discohexaster, with branched terminals,—an inconstantly occurring form. 300  $\times$ . (From Sci. Coll. Mus. Sp. No. 473).
- Figs. 17-19. Discohexasters from stalk. 300  $\times$ .
- Fig. 20. Dermal skeleton (dermalia and hypodermalia), seen surface on. About 40  $\times$ .
- Fig. 21. Gastral skeleton (gastralia and underlying parenchymalia), seen surface on. About 40  $\times$ .
- Fig. 22. Peripheral part of a section through the sponge-wall. Above, the dermal layer; below, the periphery of choanosome. About 40  $\times$ .
- Fig. 23. Part of a section through the wall. Below, the gastral layer. About 40  $\times$ .



*Sympagella anomala* Ij.





## Cretaceous Cephalopoda from the Hokkaidō.

### PART I.

#### *Lytoceras, Gandryceras and Tetragonites.*

By

**Hisakatsu Yabe,** *Rigakushi.*

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*With 7 plates.*

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#### Introductory Remarks.

In 1877, BENJAMIN SMITH LYMAN first announced the occurrence of Cretaceous Ammonites in the Hokkaidō, and his collection was examined by EDMUND NAUMANN who published a short account of the fossils without any detailed description.<sup>1)</sup> A more detailed account appeared in the work of Prof. MATAJIRŌ

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1) E. NAUMANN: Ueber das Vorkommen der Kreideformation auf der Insel Jezo. Mitth. d. deutsch. Gesell. für Natur u. Völkerkunde Ostasiens, Bd. XXI. 1880. p. 28. The following names of Ammonites are mentioned in this work:—

<i>Lytoceras Saeya</i> FORBES.	<i>Stoliczkaia</i> sp.
<i>Phylloceras</i> n. sp. aff <i>indra</i> FORBES.	<i>Anisoceras tenuisulcatum</i> FORBES.
„ cfr. <i>subalpinum</i> d'ORBIGNY.	„ sp.
„ <i>Velledæ</i> MICHELIN.	<i>Anisoceras</i> n. sp.
<i>Amaltheus sugata</i> FORBES.	<i>Ptychoceras gaultinum</i> PICTET.
<i>Haploceras</i> n. sp.	„ n. sp.
„ <i>planulatum</i> SOWERBY.	„ n. sp.
„ <i>Gardeni</i> BAILY.	

In a preliminary note in the same volume, D. BRAUNS mentions an Ammonite from Urakawa as identical with *Stephanoceras coronatum* BRUG.

YOKOYAMA,<sup>1)</sup> who described and figured Cretaceous fossils, not only of the Hokkaidō, but also of other parts of Japan. This work was indeed the first which treated systematically of the Cretaceous fauna of the Hokkaidō, but the nature and extent of the Cretaceous formation on that island was not known until the appearance of the publications of Prof. KOTORA JIMBŌ and his assistants who, for several years, were occupied in the geological survey of the whole island. JIMBŌ<sup>2)</sup>

1) M. YOKOYAMA: Versteinerungen aus der Japanischen Kreide. Palaeontographica. Bd. XXXVI. 1890. The following species of Ammonites are described in this work:—

<i>Phylloceras Velledæ</i> MICHELIN.	<i>Anisoceras</i> cfr. <i>rugatum</i> FORBES.
„ <i>ezoënsæ</i> YOKOYAMA.	„ sp.
<i>Lytoceras Sacya</i> FORBES.	<i>Desmoceras sugata</i> FORBES.
„ sp.	„ sp.
„ sp.	„ <i>Gardeni</i> BAILY.
<i>Ptychoceras pseudogaultinum</i> YOKOYAMA.	„ <i>gaudama</i> FORBES.
<i>Anisoceras subquadratum</i> YOKOYAMA.	<i>Pachydiscus ariyahurensis</i> STOLICZKA.
„ <i>Haradani</i> YOKOYAMA.	„ <i>Sutneri</i> YOKOYAMA.
„ <i>subundulatum</i> YOKOYAMA.	„ <i>Naumanni</i> YOKOYAMA.

2) K. JIMBŌ: Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaidō. Palaeontologische Abhandlungen. Neue Folge, Bd. II. Heft 3. 1894. In this work, besides *Phylloceras Velledæ* MICHELIN, *P. ezoënsæ* YOK., *Hamites pseudogaultinus* YOK., *H. Haradani* YOK., *H.* cfr. *rugatus* FORBES, *Baculites* sp., *Scaphites* cfr. *aqualis* SOW., *Pachydiscus ariyahurensis* STOL., *P. Sutneri* YOK. and *P. Naumanni* YOK., which are merely mentioned, the following forms are described:—

<i>Lytoceras Sacya</i> FORB.	<i>Acanthoceras rotomagensæ</i> DEFR. var.
„ <i>striatum</i> JIMBŌ.	<i>asiatica</i> JIMBŌ.
„ <i>crassicostatum</i> JIMBŌ.	„ <i>pseudobaculiferum</i> JIMBŌ.
„ <i>glabrum</i> JIMBŌ.	<i>Olcostephanus</i> sp.
„ <i>sphaeronotum</i> JIMBŌ.	<i>Crioceras spinigerum</i> JIMBŌ.
„ <i>denseplicatum</i> JIMBŌ.	<i>Scaphites Yokoyamai</i> JIMBŌ.
„ <i>crassum</i> JIMBŌ.	„ <i>puerulus</i> JIMBŌ.
<i>Turrilites</i> sp.	<i>Holcodiscus Kotoi</i> JIMBŌ.
<i>Hamites obstrictus</i> JIMBŌ.	<i>Pachyliscus Haradai</i> JIMBŌ.
„ <i>quadrinodosus</i> JIMBŌ.	„ <i>teshionensis</i> JIMBŌ.
„ sp.	„ <i>subtililobatus</i> JIMBŌ.
„ sp.	„ <i>Yokoyamai</i> JIMBŌ.
„ sp.	„ <i>Denisonianus</i> STOL.
„ sp.	<i>Desmoceras Damesi</i> JIMBŌ.
„ sp.	„ <i>planulatiforme</i> JIMBŌ.
„ sp.	„ <i>yubarensæ</i> JIMBŌ.
„ sp.	„ <i>Kawanoi</i> JIMBŌ.
„ sp.	„ <i>Ishikawai</i> JIMBŌ.

*Platoniceras subtilistriatum* JIMBŌ.

also wrote on the Cretaceous fauna of the island, giving an account of 47 species, of which 2 had already been described by YOKOYAMA and 6 are considered as identical with those of South India and other foreign localities, while 28 species are treated as quite new.

The Cretaceous formation in the main island of the Hokkaidō occupies a position between the coal-bearing series above and the Palæozoic rocks<sup>1)</sup> below, stretching generally north-south along the western side of the main axis of the island. It consists of deposits of a purely marine origin, with a rich fauna mostly made up of numerous Cephalopoda, Gasteropoda and Lamellibranchiata, and sometimes containing some vegetable remains. Among these three groups of the Mollusca, the Cephalopoda are the most abundant, both in species and individuals. Besides the Mollusca, we find some Brachiopoda, Echinodermata, Crustacea and sometimes also fishes;<sup>2)</sup> vertebræ of Reptilia, apparently of a Plesiosaurus, were also once obtained.

Concerning the age of the Cretaceous deposits of the Hokkaidō, various opinions have been held since the publication of the two works above referred to. YOKOYAMA, who only investigated fossils collected by others, naturally expressed a doubt as to whether all the fossils came from a single horizon, and cautiously said that the *greater part* of the fossils corresponded to those of the Utatur group of South India and consequently that they should be assigned to the Cenoman-Gault of Europe. JIMBŌ on the contrary, considered the Cretaceous fossils of the Hokkaidō as occurring in one and the same horizon of the middle Cretaceous

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1) After JIMBŌ and the general usage of Japanese geologists.

2) H. YABE: Notes on some Shark's Teeth from the Mesozoic Formation of Japan. Journ. Geol. Soc. Tōkyō. Vol. IX. No. 110. 1902.

age. European authorities, such as A. DE LAPPARENT,<sup>1)</sup> ERNST KOKEN<sup>2)</sup> and FRANZ KOSSMAT<sup>3)</sup> believed the existence of different horizons in our Cretaceous upon the palaeontological data, corresponding in age to the different subdivisions of the European upper Cretaceous. On the other hand, J. BÖHM<sup>4)</sup> and R. MICHAEL<sup>5)</sup> noticed the occurrence of fossils characteristic of the Senonian, while RUDOLF ZUBER<sup>6)</sup> expressed the opinion that the Cretaceous of the Hokkaidō and Saghalien contain lower Cretaceous type of Ammonites.

1) A. DE LAPPARENT: *Traité de Géologie*. Quatrième édition. III. 1899. Pp. 1346, 1361 and 1394.

2) ERNST KOKEN: *Die Vorwelt und ihre Entwicklungsgeschichte*. 1893. P. 421.

3) FRANZ KOSSMAT: Ueber die Bedeutung der südindischen Kreideformation für die Beurtheilung der geographischen Verhältnisse während der späteren Kreidezeit. *Jahrb. k. k. geol. Reichsanstalt*, Wien. Bd. XLIV. 1894. Heft. 3, p. 470.

KOSSMAT also criticized the Ammonites of the Hokkaidō in his "Untersuchungen über die südindische Kreideformation." He considers *Phylloceras ezōense* YOK. as a form very closely allied to *P. Forbesianum* D'ORB., while he considers *Desmoceras Danesi* JIMBŌ as probably identical with *D. suguta* FORBES. He brings *Lytoceras striatum* JIMBŌ, *L. crassicostatum* JIMBŌ and *denseplicatum* JIMBŌ under *Gaudryceras* and *L. glabrum* JIMBŌ under *Tetragonites*. One of the many *Hamites* described as *H. sp.* by JIMBŌ is regarded by him as identical with *H. (Anisoceras) largesulcatus* FORBES, and *Acanthoceras rotomagensense* DEFR. var. *asiatica* JIMBŌ as identical with *A. Noboldi* KOSSMAT. *Anisoceras* cfr. *rugatus* of YOKOYAMA, according to KOSSMAT, is distinguished by its finer, obliquely arranged ribs from that of FORBES. *Pachyliscus Denisonianus* STOL. has been divided into the three species of *Ilcodiscus sparicostatus*, *P. Jimboi* and *P. Denisonianus*, by KOSSMAT and all of them are quite different from what JIMBŌ described as such. He also doubts whether *Desmoceras Ishikawai* JIMBŌ is not a *Ilcodiscus* and takes *D. gaudana* of YOKOYAMA for a coarsely ribbed variety of *D. indopacifica* KOSSMAT.

J. F. WHITEAVES of the Geological Survey of Canada, pointed out the occurrence of *Pachyliscus Haradai* JIMBŌ and *Hamites obstrictus* JIMBŌ in the Cretaceous of Vancouver Island. (J. F. WHITEAVES: On some Fossils from the Nanaimo group of Vancouver Cretaceous. *Trans. Royal Soc. Canada*. Section IV. 1895. Pp. 130 and 132). In one of his letters to JIMBŌ in 1895, he expressed the opinion that *Desmoceras Ishikawai* might possibly be identical with *Haploceras* (afterward considered as an *Ilcoeriscus*) *cumshewaense* WHITEAVES from the Queen Charlotte Islands.

4) JOH. BÖHM: Ueber *Ammonites pedernalis* v. BUCH. *Zeitschrift d. deutsch. geol. Gesellschaft*. Bd. L. Heft. 1. 1895. P. 200.

5) R. MICHAEL: Ueber Kreidefossilien von der Insel Sachalin. *Jahrb. d. k. preuss. geol. Landesanstalt für 1898, 1899*. P. 164.

6) RUDOLF ZUBER: *Geologie der Erdöl-Ablagerungen in den galizischen Karpathen*. I. Allgemeiner Theil. Heft 1. 1899. P. 48.

The present writer went to the Hokkaidō mainly for the purpose of settling the question of the relation of the Cretaceous Ammonite-bearing deposits and the coal-bearing series, and was there during four summer vacations from 1899 to 1902 inclusive, thus having ample opportunities to make a valuable collection of the Cretaceous fossils and also careful researches in the stratigraphical order of the rocks.

He proposes the following subdivisions of the Cretaceous deposits of the Hokkaidō, although the thickness of each division has not yet been ascertained. Beginning from below, we have :

- I. The lower Ammonite-beds with *Orbitolina*-limestone.
- II. The *Trigonia*-sandstone.
  - a. Lower *Acanthoceras*-zone or *Trigonia longiloba*-zone.
  - b. *Thetis*-zone.
  - c. *Pectunculus*-zone.
- III. The upper Ammonite-beds.
  - a. Upper *Acanthoceras*-zone.
  - b. *Scaphites*-beds.
  - c. *Pachyliscus*-beds.

The upper part of the Cretaceous passes gradually into the coal-bearing series.

The layers of the Cretaceous complex are everywhere perfectly conformable to one another and evidently represent a continuous sedimentation. At the base of this formation, there is a thick complex of shales and sandstones ; in it the former predominates over the latter and contains in some places lenticular masses of limestone with *Orbitolina concava* LAM.<sup>1)</sup> This complex is what the present writer calls the lower Ammonite-beds. Above

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1) H. YABE: *Orbitolina*-Limestone in the Hokkaidō (in Japanese). Journ. Geol. Soc. Tōkyō. Vol. VIII. No. 91. 1901.

this complex is another which is also thick and consists chiefly of sandstones with subordinate layers of shale and conglomerate. This formation, being a more littoral deposit than the above, is very poor in Cephalopoda while Gasterópoda and Lamelli-branchiata, especially the remains of *Trigonia*, are common. The writer gives to this series the name of *Trigonia*-sandstone. The upper Ammonite-beds, which directly cover the *Trigonia*-sandstone, are again argillaceous, being mainly composed of shales with a few layers of sandstone. Most of the fossils described by Professors YOKOYAMA and JIMBŌ and above alluded to, as well as the greater part of my collection, were derived from these beds.

The fossils described in the following pages are partly those already treated by JIMBŌ in his work and partly those collected by the writer during his field work in the provinces of Ishikari, Teshio, Iburi and Kitami, while some are those belonging to the museum of the Science College. Not a few have been presented to the writer by gentlemen, who have kindly interested themselves in his work.

The writer begins the present memoir with the description of those groups of Ammonites which have been hitherto included in the genus *Lytoceras*, but which are now separated into *Lytoceras*, *Gaudryceras* and *Tetragonites*. A general discussion on the nature of the fauna will be given at the end of the memoir.

In the present paper, the geographical names of the Hokkaidō have been spelled according to BATCHELOR's<sup>1)</sup> system of writing Ainu names, and those of the other parts of Japan according to the system adopted by the Society for romanizing Japanese Writing. These two systems are essentially the same in principle,

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1) Ainu-English-Japanese Dictionary and Grammar by the Reverend JOHN BATCHELOR. 1889.



all the vowels being pronounced as in Italian and all the consonants as in English.<sup>1)</sup> The only difference lies in the sharp consonantal endings of many Ainu words and the existence of the sounds *hu* and *tu* in them.

The writer takes this opportunity to express his best thanks to Prof. BUNJIRŌ KOTŌ and Mr. DENKICHI YAMASHITA for the great encouragement given to him during his geological researches in the Hokkaidō. Thanks are also due to Professors M. YOKOYAMA and K. JIMBŌ for valuable suggestions in the execution of the present work. Moreover, the writer is under special obligation to the Hokkaidō Colliery Railway Company for allowing him to make thorough examinations of the strata of the coal field now being worked, and also to its chief engineers, Messrs. ROKURŌ ŌSHIMA and KIYOTSUGU YONEKURA, who were always ready to make his stay in that region as comfortable as possible. In conclusion the writer wishes particularly to thank Mr. JUNGO ISHIZAKI who has drawn all the figures except the suture lines.

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### LYTOCERAS, GAUDRYCERAS AND TETRAGONITES, IN GENERAL.

*Lytoceras* ranges from the Lias to the end of the Mesozoic, being very rich in species, from which many retrogressive genera of normal and abnormal forms have been derived. Where the upper Cretaceous deposits are developed, there we always find abnormal

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1) For the pronunciation of Japanese words see Professor BASIL HALL CHAMBERLAIN'S Handbook of Colloquial Japanese.

forms such as *Turrilites*, *Hamites* and *Baculites*. Associated with these forms, there is still a larger group of Ammonites of the same stock, which are especially numerous in the Indo-Pacific Cretaceous deposits. These Ammonites, which possess closely coiled and more or less deeply involute volutions, early attracted the attention of VICTOR UHLIG,<sup>1)</sup> who was the first to call them the "Group of *Lytoceras Saeya*" and who thought that all of the upper Cretaceous *Lytoceras* might belong to this group. In 1894, A. DE GROSSOUVRE<sup>2)</sup> proposed the new generic name *Gaudryceras* for these Ammonites. KOSSMAT<sup>3)</sup> who had an opportunity of examining better materials of these Ammonites, separated from *Gaudryceras* two other types under the names of *Tetragonites* and *Pseudophyllites*, and considered these three as subgenera of *Lytoceras*. More lately, ALPHEUS HYATT<sup>4)</sup> placed them in his second family Tetragonitidæ in the suborder Leptocampyli.

Besides these three geologically young types, remnants of another type of *Lytoceras*, of the Jurassic and lower Cretaceous formations, have also been found in the South Indian Cretaceous fauna, and in that of nearly the same age on the Pacific coast of North America. They are the Ammonites of the group of *Lytoceras fimbriatum*, or of *Lytoceras* in the most restricted sense.

Among these several types of the upper Cretaceous *Lytoceras*, there is a monotypic genus called *Pseudophyllites*, which at present has only one species, *P. indra*. This species has a very wide dis-

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1) V. UHLIG: Bemerkungen z. Gliederung karpatischer Bildungen. Jahrb. d. k. k. geol. Reichsanstalt. Bd. XLIV. Heft 2. 1894. P. 217.

2) A. DE GROSSOUVRE: Recherches sur la Craie supérieure. II partie. Les Ammonites de la Craie supérieure. Mémoires pour servir à l'explication de la carte géologique détaillée de la France. 1893. P. 225.

3) FR. KOSSMAT: Untersuchungen über die südindische Kreideformation I. Beiträge z. Palaeontologie u. Geologie Österreich-Ungarns u. d. Orients. Bd. IX. 1895. P. 17 (113).

4) ALPHEUS HYATT: Cephalopoda in Zittel's Text Book of Palaeontology. 1900.

tribution, being recorded from the Vancouver Island,<sup>1)</sup> South India<sup>2)</sup> and Madagascar;<sup>3)</sup> to which list France should also be added, as *Gaudryceras Colloti* GROSSOUVRE of that country has been proved to be identical with the above species.<sup>4)</sup> According to YOKOYAMA<sup>5)</sup> the specimen from the Hokkaidō, which had been considered by E. NAUMANN as a new species allied to *P. indra*, is too fragmentary for exact determination. Similar specimens are not contained in the writer's collection so that, much to his regret, he finds himself unable to decide whether NAUMANN's determination is correct or not.

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## LYTOCERAS SUESS.

### LYTOCERAS EZOËNSE M.

Pl. I. Fig. 1 ; Pl. V. Fig. 1.

The writer examined two specimens of this species; the one which is here figured, is nearly perfect, with a partly preserved shell and showing only a single suture line.

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1) J. F. WHITEAVES: Mesozoic Fossils. Vol. I. pt. 2. 1879. p. 105.

2) F. STOLICZKA: The Fossil Cephalopoda of the Cretaceous Rocks of Southern India. Pal. Indica. Vol. I. p. 112.—FR. KOSMAT: l. c. p. 41 (137).

3) M. M. BOULE: Note sur de nouveaux fossiles secondaires de Madagascar. Bull. du Mus. d'hist. nat. 1899.

4) A. de Grossouvre: Sur la genre *Neptychites*. Bull. Soc. géol. France. Ser. III. Tome 24.

5) M. Yokoyama: l. c. p. 175.

## Dimensions :—

		Ratio.
Diameter.	20.0 cm.	100.
Height of the last whorl.	8.0 „	40.
Breadth of the last whorl.	7.5 „	37.
Height of the whorl last but one.	2.8 „	14.
Breadth of the whorl last but one.	3.2 „	16.
Width of umbilicus.	7.0 „	35.

Shell discoidal, composed of many round whorls, increasing rather rapidly in height and breadth. Whorls nearly round, somewhat laterally compressed on the last volution, but elsewhere rather inflated, being broader than high. Umbilicus very wide, surrounded by a perpendicular wall which gradually passes to the lateral side of the whorls; the outer volutions embrace the inner ones only to a small extent. Surface covered with very numerous, transverse, fimbriate striæ, close to one another, at intervals of about two m.m. on the last volution, without any trace of periodic arrest of growth. Ribs flat, scarcely elevated, the cast of the interior being quite smooth.

Suture line shows three saddles and corresponding lobes on each side of the siphonal line, regularly diminishing in size toward the umbilical suture. Siphonal saddle elongate lanceolate and serrated along the margin. External lobe considerably shallower than the first lateral which is the broadest. External saddle unequally bifid inclining somewhat inward; first lateral saddle also asymmetrically bipartite and larger than the external one. Second lateral saddle very deeply bipartite, apparently forming two separate saddles on the umbilical wall. All branches of the saddles and lobes are repeatedly bifid and finely incised. The branchlets along both sides of the siphonal saddle are asymmetrically arranged, as shown in the accompanying figure.

The present species is distinguished from *Lytoceras Mahadeva* STOLICZKA found in the lower division of the Utatur group of Marattur, South India,<sup>1)</sup> and from *L. Batesii* MEEK of the Shasta group of California and Richardson's C horizon of the Cretaceous of Queen Charlotte Islands,<sup>2)</sup> by its whorls more rapidly increasing in height and breadth.

Localities :—The Pombets and Ponporonai, tributaries of the Ikushumbets, Prov. Ishikari.

Horizon :—Lower Ammonite-beds.

### LYTOCERAS IMPERIALE M.

Pl. II. fig. 1 ; pl. IV. fig. 1.

Among numerous specimens of Ammonites from the Cretaceous of the Hokkaidō which are yet undescribed, the present is the most striking on account of its peculiar sculpture. The following are the dimensions of the shell as actually measured in our only specimen<sup>3)</sup> :—

Diameter.	22.0 cm.	Ratio. 100.
Height of the last whorl.	10.0 „	45.
Breadth of the last whorl.	5.0 „	22.
Width of umbilicus.	7.0 „	31.

1) STOLICZKA: l. c. p. 165, Pl. LXXX. Kossnat: l. c. p. 16 (112).

2) W. M. GABB: Paleontology of California: Creta. Foss., p. 67. Pl. XIII, fig. 16 a, b.—J. F. WHITEAVES: Mesozoic Fossils. Vol. I. Pt. 1, p. 45, Pl. IX, fig. 2. Vol. I. Pt. 3, p. 202, Pl. XXVII, fig. 1.—T. W. STANTON and DILLER: The Shasta-Chico Series. Bull. Geol. Soc. America. Vol. V. 1894. P. 446.—T. W. STANTON: Contribution to the Cretaceous Paleontology of the Pacific Coast: The Fauna of the Knoxville Beds. Bull. U. S. Geol. Surv. No. 133. 1895. P. 75. Pl. XIII, figs 9—11.

3) The flattening of the body-whorl, which is at first nearly round, does not seem to be wholly due to mechanical action. It is, therefore, to be considered as one of the distinguishing characters of the species.

The inner volutions, which gradually broaden anteriorly, are nearly round in section, showing only a slight lateral compression. The body-chamber is longer than one half of the last volution; it is high and narrow. Umbilicus moderate in size; relatively narrower on the last volution than on the inner.

The surface of the septate portion is apparently smooth while the-body chamber shows radial furrows which are 15 in number; the furrows are shallow and not well defined, becoming gradually obsolete toward the umbilicus. The interspaces are flat, slightly elevated, broadest along the ventral side, measuring 1.5—2.5 cm. in breadth. These flat interspaces and furrows extend also over the ventral surface.

The suture line which is partly preserved, shows a lanceolate siphonal saddle with serrated margin. The external saddle is inclined inward and asymmetrically bifid, while the first lateral lobe is broad and deep.

The suture line and the appearance of the septate portion of this species remind us of an Ammonite of the group of *Lytoceras fimbriatum* Sow. sp., while the suddenly enlarged and laterally compressed body-whorl, together with its peculiar sculpture, distinguishes it from all the known allies.

Locality :—A cliff somewhat above the lowest gorge of the Ikushumbets, Prov. Ishikari, where the species occurs together with *Puzosia subcorbarica* m.

Horizon :—Lower Ammonite-beds.



GAUDRYCERAS GROSSOUVRE *emend.* KOSSMAT.

We have one addition to make to the remarks of KOSSMAT on the genus *Gaudryceras*, and that is respecting its suture line. Putting aside the question whether *Gaudryceras* is a well defined genus or not, it has been divided into two well marked sections, to the first of which belong *G. Agassizianum* PICTET<sup>1)</sup> from the upper Gault of Switzerland and *G. Marut* STOLICZKA<sup>2)</sup> from the Utatur group of South India. The former shows the antisiphonal lobe prolonged and reflected on the preceding septum as illustrated in detail by QUENSTEDT.<sup>3)</sup>; but the suture line of the latter has been only partly figured. The second group, or the group of *G. Saeya*, contains more than thirty species, of which there are only two,—*G. vertebratum* KOSSMAT<sup>4)</sup> and *G. varagurense* KOSSMAT<sup>5)</sup>—whose lobes have been examined; but as to the septal lobe in these two species, there exists neither a drawing nor a description. However, after careful examination of several Japanese species of *Gaudryceras*, the writer was able to find three species showing the septal lobe just as in *G. Agassizianum* Pictet. These three are *G. tenuiliratum* m., *G. striatum* JIMBŌ sp. var. *pictum* m. (Pl. IV. fig. 6 c) and *G. limatum* m., each representing a particular type in the group of *G. saeya*. The presence of the septal lobe in the above three and in *G. Agassizianum* leads us to presume that it is a character common to all species of *Gaudryceras* although

1) J. F. PICTET et W. ROUX: Mollusques fossiles des Grès Verts des environs de Genève. 1847-53. P. 47, Pl. IV. figs. 3, 4.

2) STOLICZKA: l. c. p. 162, Pl. LXXIX., fig. 1.—KOSSMAT: l. c. p. 34 (130).

3) F. A. QUENSTEDT: Handbuch d. Petrefaktenkunde. III. Auflage. 1885. P. 579, Pl. XLV. fig. 11.

4) KOSSMAT: l. c. p. 26, Pl. IV., fig. 2.

5) KOSSMAT: l. c. p. 30, Pl. I., figs. 4, 5.

it is not usually visible unless the specimen is in a very favorable state of preservation.

All the species of *Gaudryceras* seem to be very imperfectly known. This is partly due to the fact that although they are very common especially in the upper Cretaceous deposits of the Indo-Pacific region, the specimens usually belong to immature animals, and consequently closely resemble one another so that the determination is not only very difficult, but often quite impossible. Moreover, the aspect of the shell of this genus is so different in its younger and older stages, that without a large series of specimens for comparison, the larger and smaller forms are often liable to be separated into distinct species. There are already several instances of confusion among the species of this genus. The full specific character, as it seems to the writer, appears always in the mature stage or at least after the shell has attained the middle stage of its life. The differences existing among the young individuals of different species are very slight and often apparently less marked than those between individuals in one and the same species, while the shell of the full grown forms of each species is well characterized and easily distinguishable from its allies. However, owing to the rapid enlargement of whorls in adult specimens and the extreme thinness of the shell, it is not always easy to get specimens with a well preserved shell.

The largest Japanese species is *Gaudryceras tenuiliratum*, one of the specimens measuring over 30 cm. in diameter and being entirely septate, but still showing the sharp ribs as usual. The following is what FR. SCHMIDT<sup>1)</sup> wrote about an Ammonite from the Cretaceous of Saghalien which he identified with *G. Sacya*.

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1) FR. SCHMIDT: Die Petrefakten der Kreideformation von der Insel Sachalin. 1873. P. 16.

“Bei meinem grössten Stück, das über einen Fuss im Durchmesser hielt, und von dem ich nur ein Bruchstück mitgebracht habe, ist der Steinkern der äussersten Windung ganz glatt, nur über and über mit ineinander gewirrter Lobenzeichnung bedeckt; die erwähnten dichterem Rippen sieht man an nächst der inneren Windung des nämlichen Stücks.”

The smoot state of the outer volutions of the older individuals, as above referred to, is very common also in the Japanese species of *Pachydiscus*, but has never yet been observed in the *Gaudryceras*, occurring very abundantly in the Hokkaidō and sometimes also in Amakusa.

The writer is now acquainted with nine species and five varieties of *Gaudryceras* from the Hokkaidō, all of which belong to the category known as ‘the group of *Gaudryceras Sacya*.’ This group is again divisible into six subgroups, chiefly according to the character of the full grown shells.

#### I. Subgroup of *Gaudryceras tenuiliratum* YABE.

This subgroup is characterized by the full-grown whorl having numerous ribs of two kinds, a number of narrower ribs being inserted between each pair of broader ribs. The latter on a closer examination are found to be made up of two or three finer ribs placed close together. The whorls grow exceedingly rapidly in height and breadth.

The type is *G. tenuiliratum*<sup>1)</sup> from the upper Ammonite beds of the Hokkaidō and is very variable in form. *G. varagurens* KOSSMAT<sup>2)</sup> sp. probably belongs to this subgroup, and *G. mite*

1) Vide p. 19.

2) KOSSMAT: l. c. p. 26 (122), Pl. IV (XVIII), fig. 2 a, b, c; Pl. III (XVII), fig. 9.

HAUER<sup>1)</sup> sp. from the Senonian of Gossau and France is also referable to this subgroup.

## II. Subgroup of *Gaudryceras crassicostatum* JIMBŌ sp.

Whorls compressed on the sides, with broad ribs and finer interstitial ones. Suture line in young specimens more complicated than in those of the first subgroup. The type is *G. crassicostatum* JIMBŌ<sup>2)</sup> sp. The two other species from the Hokkaidō—*G. denseplicatum* JIMBŌ<sup>3)</sup> sp. and *G. striatum* JIMBŌ<sup>4)</sup> sp.—show a sculpture somewhat deviating from this type species. *Ammonites glanegensis* REDTENBACHER<sup>5)</sup> from the Gossau formation of the north-eastern Alps, being intermediate between *G. tenuiliratum* and *G. denseplicatum*, forms a connecting link between this subgroup and the preceding. *G. subtililineatum* KOSSMAT sp. is also probably referable to this subgroup.

## III. Subgroup of *Gaudryceras limatum* YABE.

The striæ on the whorls in young specimens are so extremely fine that the surface appears to be almost smooth. The adult shells present ribs which are broad and elevated, and crowded together without any interstitial striae as in the foregoing subgroup. Suture line very complicated, characterized by the bipartite second

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1) FR. v. HAUER: Neue Cephalopoden der Gosaugebilde. Sitzungsab. Akad. Wiss. Wien. 1866. Bd. LIII. p. 7 (305), Pl. II., figs. 3-4. A. DE GROSSOUVRE: l. c. p. 227, Pl. XXVI., fig. 4; Pl. XXXIX.

2) Vide p. 29.

3) Vide p. 30.

4) Vide p. 31.

5) ANTON REDTENBACHER: Die Cephalopodenfauna d. Gosauschichten in d. nordöst. Alpen. Abh. d. k. k. geol. Reichsanstalt. Bd. V. Heft 5. P. 119, Pl. XXVII., fig. 3.

lateral lobe. Type:—*G. limatum* m.<sup>1)</sup> *G. politissimum* KOSSMAT<sup>2)</sup> from the upper Trichinopoly group of South India is a species closely resembling this Japanese form. *Lytoceras* sp. of SCHLÜTER<sup>3)</sup> from the Senonian of Germany may also be cited as an ally of the latter.

#### IV. Subgroup of *Gaudryceras denmanense* WHITEAVES.

This embraces these Ammonites whose surface bears numerous simple, equal, sharp ribs in the full grown state. It is closely related to the first subgroup, but is distinguished from it by the absence of periodic ribs. Type:—*G. denmanense* WHITEAVES sp.,<sup>4)</sup> once treated as *L. Jukesii*? SHARPE<sup>5)</sup>, and considered by KOSSMAT<sup>6)</sup> as identical with *G. Kayei* FORBES sp. *G. Jukesii* is a species from the Senonian of England which was founded on a single fragment.

#### V. Subgroup of *Gaudryceras Sacya* FORBES sp.

A full grown shell shows many, very shallow and narrow, transverse grooves separated by wide interspaces. The suture line resembles that of the subgroup of *G. tenuiliratum*. Type:—*G. Sacya* FORBES<sup>7)</sup> sp., the adult specimens of which were called by

1) Vide p. 34.

2) KOSSMAT: l. c. p. 32 (128), Pl. L (XV). figs. 7 a, b, c.

3) SCHLÜTER: Cephalopoden d. oberen deutschen Kreide. P. 16, Pl. XLII. figs. 6, 7.

4) WHITEAVES: On some Fossils from the Nanaimo group of the Vancouver Cretaceous. 1895. P. 129, Pl. II. figs. 1-2. Note on a Supposed New Species of *Lytoceras* from the Cretaceous Rocks at Denman Island. Ottawa Naturalist. 1901. Vol. XV. No. 2, p. 31.

5) WHITEAVES: Mesozoic Fossils. Vol. I. Pt. 2, p. 119, Pl. XIII. figs. 3, 3 a, b.

6) KOSSMAT: l. c. p. 125.

7) STOLICZKA: l. c. p. 154, Pl. LXXV. figs. 5-7; Pl. LXXVI. figs. 1-3.—WHITEAVES: l. c. Vol. I. Pt. 1, p. 43, Pl. II. figs. 2 a, b, c, 3. Pt. 3, p. 203, Pl. XXV.—KOSSMAT: l. c. p. 23 (119).

FORBES *Ammonites Budha*. The single fragment of an Ammonite from the Hokkaidō shows the character of the subgroup.

VI. Subgroup of *Gaudryceras varuna* FORBES sp.

This subgroup holds a somewhat isolated position as compared with the above five, including *G. varuna* FORBES sp.,<sup>1)</sup> *G. odiense* KOSSMAT sp.,<sup>2)</sup> *G. anaspatum* REDTENBACHER sp.<sup>3)</sup> and *G. Kawanoi* JIMBŌ sp.<sup>4)</sup> The whorls of these species are considerably compressed on the side, the involution being very deep and the umbilicus narrow from the beginning of the shell, while the surface is nearly smooth. To these differences is still to be added another concerning the course of the suture line. There are numerous auxiliary lobes slowly diminishing in size toward the umbilicus.

Although it appears somewhat artificial to make such subdivisions of *Gaudryceras* as above enumerated, yet in this way, not only geologically younger forms are easily separated from the older, but also the extreme confusion which has hitherto prevailed among the Ammonites of the whole group may also be avoided.

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1) KOSSMAT: l. c. p. 34 (130); p. 65 (161), Pl. II (XVI), figs. 4 a, b; Pl. III (XVII), fig. 8.

2) KOSSMAT: l. c. p. 33 (129), Pl. IV (XVIII), fig. 1 a, b, c; Pl. V (XIX), fig. 3.

3) REDTENBACHER: l. c. p. 113, Pl. XXVI, fig. 1.

4) Vide p. 41.



SUBGROUP OF GAUDRYCERAS TENUILIRATUM.

GAUDRYCERAS TENUILIRATUM M.

Pl. III., figs. 3 and 4.

1890. *Lyloceras Sacya* YOKOYAMA: Versteinerungen aus der japanischen Kreide. P. 178, Pl XVIII. figs. 12 a, b, 13 a, b.

1894. *Lyloceras Sacya* JIMBŌ: Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaidō. P. 13 (159)—18 (164).

This species is the most common form in our Cretaceous, playing the rôle of the leading fossil of the upper Ammonite-beds. It has long been known under the name of '*Lyloceras Sacya*' and the occurrence of the middle Cretaceous in Hokkaidō has been based by several authorities on this determination. The writer took special care in studying this species, as it has been often much confounded with allied forms.

Dimensions :—

	(1)		(2)		(3)		(4)		(5)	
Diameter.	30.0 cm.	100.	23.0 cm.	100.	4.2 cm.	100.	3.95 cm.	100.	3.50 cm.	100.
Height of the last whorl.	16.0 "	53.	13.0 "	56.	— "	—	1.45 "	36.	1.2 "	34.
Breadth of the last whorl.	16.5 "	53.	12.0 "	52.	1.6 "	38.	1.45 "	36.	1.35 "	38.
Width of umbilicus.	5.5 "	18.	4.8 "	20.	1.8 "	42.	1.60 "	40.	1.50 "	42.

1) The largest specimen ever found; from a cliff opposite the mouth of the Panke-moyūbari, a branch of the Yūbarigawa.

2) A specimen from Urakawa.

3) A specimen from Urakawa (after YOKOYAMA).

4) A specimen from the Kikumezawa, a tributary of the Ikushumbets.

5) A specimen from the Kikumezawa, a tributary of the Ikushumbets.

The description of this species by YOKOYAMA is very accurate, but it is based on young specimens and not on adult ones. The full-grown individual of *G. tenuiliratum* must have attained a considerable size, for a specimen from a cliff opposite the mouth of the Panke-moyūbari measures 30 cm. in diameter and is entirely septate. By removing the outer volutions, we can trace each stage of development back to the embryonal chamber. However, when specimens are very small, it is not always easy to determine whether they represent a young stage of the present species or of other allied forms. That the young and adult specimens belong to one and the same species is shown by the abundant occurrence of many transitional forms. For the sake of convenience the writer describes this species in three different stages of development, although in fact there is no sharp boundary between any two of them.

The **young** stage<sup>1)</sup>:—Shell discoidal, composed of many slightly involute whorls. A specimen, 3.5 cm. in diameter, is composed of six volutions. Whorls transversely reniform, broader than high and broadest near the umbilical edge. Umbilicus very wide, with a moderately steep wall.

Surface with very numerous fine striae and few periodic ribs; striae unequal in length, more or less S-shaped and acute, much narrower than their interspaces. The longest striae embrace the entire surface of the whorl, while the shortest ones are only on its ventral side; others are on the ventral as well as on the

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1) YOKOYAMA: l. c. Pl. XVIII. fig. 13.

lateral sides. All of these striæ are very fine, but their size varies much in each individual. The periodic ribs are round and parallel to the striæ, five of them being on each volution, and correspond to faint grooves on the cast of the interior. These ribs are also covered with fine striæ.

The suture line has one external, two lateral and three auxiliary saddles, diminishing gradually in size toward the umbilical suture.

The above description and that of YOKOYAMA clearly indicate that this Ammonite is closely related to *G. multiplexum* Koss.<sup>1)</sup> (= *G. Sacya* FORBES var. *multiplexum* STOLICZKA), with which YOKOYAMA indeed identified it, while KOSSMAT considered it to be *G. Sacya*. The former species is distinguished from this by the different forms of the auxiliary saddles. The latter, when compared with this, possesses less numerous volutions, although it is often impossible to find this distinction, when we have not full grown forms before us. *G. denmanense* WHITEAVES<sup>2)</sup> sp. from the Vancouver Cretaceous which is identified with *G. Kayei* FORBES by KOSSMAT, is also hardly distinguishable from the young forms of the present species.

WHITEAVES, after a direct comparison of the specimens of his *G. denmanense* with those of *G. tenuiliratum* which had been sent to him for examination, informed the writer that he saw at present, no reason why the latter should be distinguished from the former. *G. alamedense* J. P. SMITH<sup>3)</sup> is also certainly related to *G. tenuiliratum*, but according to the above author to whom

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1) KOSSMAT: l. c. p. 25 (121), Pl. I (XV), figs. 6 a, b, c.

2) WHITEAVES: On Some Fossils from the Nanaimo group of the Vancouver Cretaceous 1895. P. 129, Pl. II. figs. 1-2.

3) SMITH: The Development of *Lytoceras* and *Phylloceras*. Proc. Calif. Acad. Sci. Series. III. Vol. I. No. 4. 1898. P. 136.

some specimens of the Japanese species were also sent for comparison, the Californian form is said never to attain such a large size, and to be less involute. This is the more remarkable, as the specimens sent to him were all of a young stage. Now, as shown by the descriptions of the varieties of this species, the involution of whorls is also not always constant, therefore it seems to the writer that the distinction based on this character is not of much value. *G. varagurens* KOSSMAT<sup>1)</sup> from the Trichinopoly group of South India is also one of the nearest allies, but it possesses a more compressed shell and higher whorls.

The **middle stage**<sup>2)</sup>:—Whorls rather rapidly growing in height and breadth; the height and breadth being at first nearly equal, while later the height becomes greater than the breadth. Umbilical wall very steeply inclined.

Surface with striae and ribs, the shortest striae disappearing imperceptibly as the shell grows, while the remaining ones, on the contrary, become thicker and more elevated and separated by wider intervals than on the whorls of the young stage. Ribs very numerous, with seven or eight striae between, somewhat elevated, round, composed of two or three striae which are very close together and run into one on the lateral side. Involution also somewhat deeper, about one half of the preceding volution being covered.

Suture line as in the preceding stage with some slight complications.

*G. mite* HAUER<sup>3)</sup> and *G. varagurens* KOSSMAT in form closely resemble this stage. The first species which is from the

1) KOSSMAT: l. c. p. 26 (122, Pl. IV (XVIII), figs. 2a, b, c; Pl. III (XVII), fig. 9.

2) YOKOYAMA: l. c. Pl. XVIII. figs. 12 a, b.

3) HAUER: l. c. p. 7 (305), Pl. II. figs. 3-4. A. DE GROS-OUVRE: l. c. p. 227, Pl. XXVI. fig. 4; Pl. XXXIX.

Gossau bed of the Alps, on comparison, has less involute whorls (about  $\frac{1}{3}$ ) and the ribs are less conspicuous. *G. varagurens* which is allied to *G. tenuiliratum* in the young stage of its shell, is a species based on fragments from the upper Trichinopoly group of Varagur, South India. It shows only one periodic rib in a space corresponding to the last quarter of the last volution.

The **mature** stage:—Whorls enlarging very rapidly; rounded and at the same time broadest at the umbilical edge, the breadth from this point gradually diminishing toward the ventral side. Involution more than  $\frac{1}{2}$ . Umbilicus narrow, very deep, surrounded by a perpendicular wall.

Surface with very narrow, sharp, prominent, simple, transverse ribs whose greater part entirely surrounds the whorls. Between the ribs, sometimes, shorter ones of the same character are inserted. Interspaces between the ribs flat, measuring 2 mm. on the ventral side. Periodic ribs composed of a partial union of two ordinary ribs, with a regular interspace of about 2–3 cm. along the ventral side, 22 of which are on the last volution of the largest well preserved specimen.

The suture line is of the same type as in the preceding stage, only it is very much complicated, the accompanying figure having been taken from a large fragment found on the Bannosawa which is, no doubt, considerably larger than that which the writer has already referred to at the beginning.

The full specific character is shown after the Ammonite has attained its adult stage. The full grown shell is quite different from others in form, while that of the young or middle stage is very liable to be confounded with allied species. This may be partly due to the fact that the adult shells of the allied forms are mostly imperfectly known.

*G. denmanense* WHITEAVES<sup>1)</sup> shows phases of growth similar to those of *G. tenuiliratum*. Its adult stage is provided with a single kind of ribs which are somewhat thicker and separated by wider intervals than in Japanese species.

*G. glunegense* REDTENBACHER<sup>2)</sup> from the Gossau formation of the Alps also more or less closely resembles the Japanese species, showing surface marking intermediate between it and *G. densiplicatum* JIMBŌ sp.

Localities :—Abundant wherever the *Pachydiscus*- and the *Scaphites*-beds occur, but especially frequent in the *Pachydiscus* beds. Found in Sorachigōri and Yūbarigōri in the Province of Ishikari; Yūfutsugun in the Province of Iburi; along the Opiraushibets, and the Abeshinai, a tributary of the Teshiogawa, in the Province Teshio; Urakawa, in the Province of Hidaka; Sōyagori, in the Province of Kitami. Outside of the Hokkaidō, this species has been also found in the Cretaceous of Amakusa.<sup>3)</sup>

### I. Variety with a Wider Umbilicus.

#### VAR. **ORNATA** M.

Pl. III., figs. 2 a, b.

Compare :—

1865. *Ammonites Kayei* STOLICZKA: l. c. p. 15, Pl. LXXVII. fig. 1.

1871. *Ammonites Kayei* GRIESBACH: Geology of Natal. Quart. Journ. Geol. Soc. London. Vol. XXVII. p. 63.

1) WHITEAVES: On Some Fossils from the Nanaimo Group of the Vancouver Cretaceous. p. 129, Pl. II. figs. 1-2.

2) REDTENBACHER: l. c. p. 119, Pl. XXVII. figs. 3 a, b.

3) H. YABE: Note on Three Upper Cretaceous Ammonites from Japan. P. 10.



1895. *Lytoceras Kayei* STEINMANN: Die Cephalopoden d. Quiriquina Schichten. Neues Jahrb. f. Mineral., Geol. und Palaeont., Beilageband X. p. 86, Pl. V. fig. 5 a, b.

1895. *Lytoceras (Gaudryceras) Kayei* KOSSMAT: l. c. p. 162, Pl. II (XVI), fig. 5 a, b; Pl. III (XVII), fig. 2 a, b.

Dimensions :—

	(1)	Ratio	(2)	Ratio	(3)	Ratio	(4)	Ratio	(5)	Ratio	(6)	Ratio
Diameter.	5.85 cm.	100	4.00 cm.	100.	2.25 cm.	100.	2.10 cm.	100.	2.30 cm.	100.	1.26 cm.	100.
Height of the last whorl.	1.85 „	32	1.20 „	30.	0.65 „	28.	0.60 „	28.	— „	—	0.30 „	24.
Breadth of the last whorl.	1.80 „	31	1.35 „	34.	0.75 „	33.	0.70 „	33.	0.70 „	30.	0.50 „	40.
Width of umbilicus.	2.75 „	47	1.80 „	45.	1.20 „	53.	1.10 „	52.	1.20 „	52.	0.70 „	56.

1). A specimen of *G. Kayei* from the Valudayur beds of Pondicherry (after KOSSMAT).

2). A specimen of var. *ornata* from the *Pachydiscus*-beds of the Kikumezawa (Pl. III. fig. 2 a, b).

3). A specimen of *G. Kayei* from South India (after FORBES).

4). A specimen of *G. Kayei* from the Quiriquina bed of Chili (after STEINMANN).

5). A specimen of var. *ornata* from the upper Ammonite beds of the Ikushumbets.

6). A specimen of *G. Kayei* from the Valudayur beds of Pondicherry (after KOSSMAT).

The specimen, No. 5, consists of seven volutions. The umbilicus is very wide, being broader than one half of the whole diameter of the shell, slightly covering the ventral portion of the preceding volutions. Aperture subquadrate, broader than high; in older stages, becoming higher and laterally compressed. Surface

with exceedingly fine striæ and five periodic elevations. The suture is similar to that of the normal form, the head of the first auxiliary saddle touching the umbilical suture which is followed by two or three small denticulations.

This variety is distinguished by a very slow growth of whorls and an umbilicus wider than the normal form. The writer thought at first that this form was a distinct species, and probably identical with *G. Kayei* FORBES sp. from the Senonian deposits of S. India,<sup>1)</sup> Natal,<sup>2)</sup> Chili<sup>3)</sup> and Tunis,<sup>4)</sup> whose European ally is *G. planorbiforme* BÖHM sp.,<sup>5)</sup> but the presence of many transitional forms between this and the normal specimen of *G. tenuiliratum* convinced him that it is impossible to treat them as different species.

The above mentioned characters being common to this variety and *G. Kayei*, it is doubtful whether the greater part of the forms described as *G. Kayei* are not a mere variety of *G. tenuiliratum*.

It is quite impossible to decide whether an Ammonite described under the name of *G. planorbiforme* resembles Senonian or Cenomanian forms when we have only young specimens. The writer is also in doubt whether the large individuals figured in Pl. XXXIV. fig. 4, 5. and Pl. XXXV. fig. 7, by A. de Grossouvre really belong to the adult stage of *G. planorbiforme*.

An Ammonite from the Vancouver Cretaceous first described

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1) STOLICZKA: l. c. KOSSMAT: l. c.

2) GRIESBACH: l. c.

3) STEINMANN: l. c.

4) L. PERVINQUIÈRE: Sur un faciès particulier de Sénoïen de Tunisie. 1898. (by referat).

5) J. BÖHM: Paleontographica. Bl. XXXVIII. p. 49, Pl. I. fig. 12.—V. UHLIG: Bemerkungen z. Gliederung karp. Bildungen. Jahrb. d. k. k. geol. Reichsanstalt. Wien, 1894. P. 216, fig. 1.—GROSSOUVRE: l. c. p. 231, Pl. XXVII. fig. 2.

as *L. Jukesi* SHARPE? and afterward under the name of *L. denmanense* sp. nov. and considered to be identical with *G. Kayei* by KOSSMAT, is believed by the writer to be a distinct species, he in this respect agreeing with the latest view of WHITEAVES.

Localities:—The Kikumezawa, a tributary of the Ikushumbets, and the upper course of the latter; one from each locality.

Horizon :—*Pachydiscus*-beds.

## II. Varieties with a Narrower Umbilicus and Coarser Ribs.

### VAR. **INTERMEDIA.** M.

Pl. III., figs. 1 a, b.

1895. *Lytoceras Sacya* JIMBŌ : l. c. p. 34 (180), Pl. VI. fig. 1.

1895. *Lytoceras denseplicatum* var. JIMBŌ : l. c. p. 36 (182).

Dimensions :—

	(1) Ratio.		(2) Ratio.		(3) Ratio.		(4) Ratio.	
Diameter.	3.1 cm.	100.	3.40 cm.	100.	4.1 cm.	100.	11.7 cm.	100.
Height of the last whorl.	1.3 "	41.	1.45 "	42.	1.8 "	43.	5.7 "	48.
Breadth of the last whorl.	1.3 "	41.	1.50 "	44.	1.5 "	36.	5.3 "	45.
Width of umbilicus.	1.05 "	33.	1.10 "	32.	1.3 "	30.	3.0 "	25.

1) A specimen from the Yūbarigawa, Prov. Ishikari.

2) The original of JIMBŌ's Pl. VI. fig. 1; loc. Yūbarigawa.

3) A specimen from the Penke-moyūbari.

4) A specimen from the Sanushibe, Prov. Iburī.

This variety is distinguished from the normal form by the following characters :—

When young, the whorls grow more rapidly in height; the umbilicus is narrower and somewhat deeper, a little more than

one third of the inner volution being visible; the aperture is nearly round; the striae on the surface are coarser.

The suture line is the same in both.

This variety differs from *G. madraspatanum*<sup>1)</sup> BLANFORD sp. from the lower Utatur group of South India in its coarser striae; but in form they are remarkably alike.

*Lytoceras* sp. (YOKOYAMA: l. c. p. 80, Pl. XIX. fig. 3 a, b.) may probably be referred to this variety, as it agrees quite well in form and sculpture; periodic ribs are very indistinct in this and the next variety, being almost invisible in some specimens, although more distinct in exceptionally well preserved ones.

A specimen from the Hokkaidō in the Imperial Museum of Natural History in Berlin was considered by JIMBŌ, to be a variety of *G. denseplicatum*. But the examination of a plaster-cast kindly sent to the writer by O. JECKEL, the director, shows that it really belongs to this variety of *G. tenuiliratum*.

Localities :—The Yūbarigawa, above the mouth of the Panke-moyūbari; the Ikushumbets; the Sanushibe, a tributary of the Popets. Five specimens were examined.

Horizon :—Upper Ammonite-beds. Exclusively in the *Pachydiscus*-beds?

#### VAR. INFREQUENS M.

Pl. IV., fig. 3 a, b.

1894. *Lytoceras Sacya* JIMBŌ (par.): l. c. p. 34 (180).

Dimensions :—

Diameter.	4.30 cm.	Ratio. 100.
Height of the last whorl.	1.75 „	40.

1) STOLICZKA: l. c. p. 151, Pl. LXXV. fig. 2.—KOSSMAT: l. c. p. 32 (128).

Breadth of the last whorl.	1.90 cm.	44.
Width of umbilicus.	1.40 „	32.

Shell broader than in other varieties; whorls broaden slowly toward the mouth, broader than high. Umbilicus wide, surrounded by a vertical wall. Surface with striæ of the same type as in the preceding variety but considerably coarser and more prominent.

Localities :—On the Opiraushibets, about 35 miles from its mouth, Prov. Teshio; Makka-ushipe, a branch of the Sanushibe, Prov. Iburi; the Kikumnezawa, a tributary of the Ikushumbets Prov. Ishikari. Only one specimen from each locality was examined.

Horizon :—Upper Ammonite-beds.

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## SUBGROUP OF GAUDRYCERAS CRASSICOSTATUM.

### GAUDRYCERAS CRASSICOSTATUM JIMBŌ sp.

Pl. IV., fig. 4.

1894. *Lytoceras crassicostatum* JIMBŌ: l. c. p. 36, Pl. VI.  
figs. 7, 7 a.

This species is exceedingly rare. It was first founded on a somewhat water-worn but yet full grown specimen from Cape Soya in the Province of Kitami. The writer has drawn up the following diagnosis from an examination of a specimen which belongs to a young stage.

## Dimensions :—

		Ratio.
Diameter.	4.5 cm.	100.
Height of the last whorl.	1.5 „	33.
Breadth of the last whorl.	1.2 „	26.
Width of umbilicus.	2.1 „	46.

Shell discoidal, compressed ; composed of about 7 volutions. Umbilicus very wide, about twice as broad as the height of the whorl, becoming gradually narrower as the shell grows. The inner volutions slightly inflated, merely touching one another, but the last volution is higher than broad, embracing one half of the preceding one. The surface sculpture is similar to that of *G. tenuiliratum*, but the striae become gradually finer toward the mouth where the shell appears almost smooth. The whorls of the later stages possess many thick periodic ribs as shown in fig. 7, Pl. VI. in the work quoted above.

This species, being characterized by the peculiar sculpture of the adult specimen, and the very loosely coiled volutions of the young individual, is easily distinguished from others.

Locality : Cape Sōya, Prov. Kitami.

Horizon : Upper Ammonite-beds.

### GAUDRYCERAS DENSEPLICATUM JIMBŌ sp.

1894. *Lytoceras denseplicatum* JIMBŌ : l. c. p. 36 (182), Pl. III. fig. 1.

This beautiful but rare form is represented by a single specimen in the writer's collection, this and the type figured by Jimbō being the only ones found up to the present time. The writer's specimen is less complete than JIMBŌ's, having only a part of



the last volution which is marked by the characteristic sculpture of the adult stage. When judged from the sculpture, the Japanese form comes near to *Gaudryceras glanegense* REDTENBACHER<sup>1)</sup> from the Gossau formation of the Alps which, with a somewhat similar form and sculpture, shows a position intermediate between this species and *G. tenuiliratum*.

It is not yet possible to ascertain the exact relation between the present form and *G. striatum* JIMBŌ sp. described below, because the imperfect state of preservation of the former does not allow the examination of its inner volutions which alone would settle its relation to the latter.

Localities:—The type specimen of JIMBŌ is from the Ekimomano, a tributary of the Yūbarigawa, while the other is from a cliff of the Yūbarigawa, close to its junction with the Penkemyōbari.

Horizon:—*Pachydiscus*-beds.

### GAUDRYCERAS STRIATUM JIMBŌ sp.

Pl. IV., fig. 5.

1894. *Lytoceras striatum* JIMBŌ: l. c. p. (181), Pl. VI. fig. 6 a, b.

The type specimen, which has been described and figured in the above paper, is a young individual of 4.7 cm. in diameter from the Abeshinai-rubeshibe, a tributary of the Teshiogawa. Another less imperfect but somewhat larger specimen from the same place has been lately found in the collection of JIMBŌ which necessitates the revision of the diagnosis given by him.

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1) REDTENBACHER: l. c. p. 119, Pl. XXVII. fig. 3.

## Dimensions :—

		Ratio.
Diameter.	7.2 cm.	100.
Height of the last whorl.	3.0 „	41.
Breadth of the last whorl.	2.8 „	38.
Height of the whorl last but one.	1.2 „	16.
Breadth of the whorl last but one.	1.4 „	19.
Width of umbilicus.	2.4 „	33.

Inner volutions broader than high; when 4.0 cm. in diameter, they are as high as broad, after which they rapidly increase in height, so that a cross-section near the mouth of the larger individual shows a subquadrate form, higher than broad, being broadest near the umbilical edge, but narrowing toward the rounded ventral side. A change also takes place in the surface sculpture, just as in *G. tenuiliratum* and *G. crassicostatum*. The surface is at first covered with numerous very fine striæ and about five periodic ribs, corresponding to the feeble furrows on the cast. The striæ and the ribs are slightly S-shaped as is usual in shells of this genus. These periodic ribs appear more frequently when the shell has attained a diameter of about 5 cm. The figured specimen shows 7 of them on the last quarter of the last whorl. The suture line of our specimen when compared with that shown in fig. 6 b, Pl. VI. of JIMBŌ's work, is far more finely toothed.

The relation of this species to *G. denseplicatum* JIMBŌ sp. has been already alluded to. It does not appear, at first sight, to be different from the subgroup of *G. tenuiliratum*, and it is commonly not easy to distinguish the former from the finely sculptured variety of the latter. The main points in which they differ lie in the fact that the suture line in *G. striatum* is more finely divided than in *G. tenuiliratum*, and the thicker ribs and

their interspaces on the former are uniformly covered with very fine striæ which do not become gradually coarser and less in number in the older volutions, as we have seen in *G. tenuiliratum*.

On account of the above characters I have provisionally referred *G. striatum* to the subgroup of *G. crassicostatum*, although its affinity to this subgroup is not very close, as is also the case with *G. denseplicatum*.

Locality:—The Abeshinai-rubeshibe, a tributary of the Teshiogawa, Prov. Teshio. We possess only two specimens—one of which is the original of JIMBŌ's illustration and the other is represented in figure 5 in Pl. IV.

Horizon :—*Pachydiscus*-beds.

# VAR. **PICTA** M.

Pl. IV., fig. 6 a, b, c.

The third specimen of *G. striatum* is a somewhat modified form; the following table exhibits the dimensions measured on the external as well as on the internal volutions of the same specimen.

Dimensions :—

	Ratio.		Ratio.	
Diameter.	5.6 cm.	100.	1.50 cm.	100.
Height of the last whorl.	3.3 „	41.	0.45 „	30.
Breadth of the last whorl.	2.3 „	41.	0.60 „	40.
Width of umbilicus.	2.0 „	35.	0.75 „	50.

From the above table it is evident that the form of this variety varies greatly in various stages of its growth. It is distinguished from the normal type by its broader whorls whose cross-section is quadrate.

The specimen is in a good state of preservation. The shell

is composed of six volutions, the inner ones showing a wide umbilicus and very inflated whorls which are broader than high, and strikingly resembling *G. tenuiliratum* of the same size. All the whorls become gradually higher as they grow, so that their height and breadth become almost equal, showing a nearly square cross-section when the shell measures 5 cm. in diameter. The ventral side is round and broad.

In other respects, that is, in its shape, surface markings and the suture line, it does not show any appreciable difference from the normal type of the species. The septal lobe is beautifully preserved, as shown in fig. 6 c, Pl. IV.

Locality and Horizon :—*Pachyliscus*-beds of the Uipets-imbeshibe, a tributary of the Uipets, Prov. Teshio.

## GROUP OF GAUDRYCERAS LIMATUM.

### GAUDRYCERAS LIMATUM M.

Pl. IV., fig. 2; Pl. V., fig. 2; Pl. VI., figs. 3 a, b.

Of the many specimens of Ammonites referable to the present species and its varieties, one half are provided with whorls of the adult stage, although in a more or less deformed state.

Dimensions :—

	(1)		(2)	
		Ratio.		Ratio.
Diameter.	8.2 cm.	100.	7.7 cm.	100.
Height of the last whorl.	3.5 „	42.	3.0 „	38.
Breadth of the last whorl.	3.2 „	39.	— „	—.
Width of umbilicus.	2.7 „	32.	2.6 „	33.

1) A specimen from the Ikushumbets. (Pl. IV., figs. 3 a, b).

2) A specimen from the Yūbarigawa. (Pl. IV., fig. 2).

Shell discoidal, somewhat compressed, composed of numerous whorls; whorls oblong, becoming gradually higher as the shell grows, the broadest part lying near the umbilical edge. Umbilicus wide, shallow, exposing nearly three-fifths of the inner volutions; Umbilical wall perpendicular, surrounded by a rounded edge. The suture of the shell except on the last volution is smooth, being provided only with very fine striæ of growth. The striæ begin at the umbilical suture, bend forward at its edge and extend into the lateral side of the whorl with a slight flexure, passing straight over the ventral side. When the shell becomes larger than about 8-9 cm. in diameter, the thick transverse ribs gradually begin to appear, encircling the whorl parallel to the striæ and rapidly becoming broader and more elevated toward the periphery. These ribs are broad, measuring 0.6 cm. in average breadth with interspaces of about 0.4-0.8 cm. in breadth on the siphonal line. However they become broader and more closely set together toward the mouth. Suture line very complicated; the external saddles as well as two lateral ones and the first auxiliary are bipartite, while the remaining three auxiliaries are simple. The lobes are narrow, the two lateral ones being bipartite. The auxiliary saddles and lobes hang obliquely on the umbilical wall. The septal lobe has been seen in a well preserved specimen.

There is only one ally of the present form, and that is *Gaudryceras politissimum* KOSSMAT sp.<sup>1)</sup> from the upper Trichinopoly group of Varagur, South India. This Indian species resembles in many respects the Japanese. It is known only by a specimen at the middle stage of growth, which is distinguished

1) KOSSMAT: l. c. p. 32 (128), Pl. I. (XV), figs. 7 a, b, c.

by a wider umbilicus and relatively low, much compressed whorls. Still there is no doubt that there exists an intimate relation between these two forms.

The Japanese species is very variable in its form; some (Pl. V., fig. 2) show a wider umbilicus and lower whorls, strongly reminding us of the form of *G. politissimum*, while others are characterized by a narrower umbilicus, higher whorls and the earlier appearance of broad ribs. The latter is now considered merely as a variety (var. *obscura*). Fig. 3 a, b. in Pl. VI. is a form intermediate between this and the normal type.

Localities and Horizon :—The upper course of the Ikushumbets, above the mouth of the right branch, the Yoshiashizawa, and along the latter itself; found in the upper Ammonite-beds. Along the Opiraushibets, Prov. Teshio, in the *Scaphites*-beds.

### GAUDRYCERAS YOKOYAMAI M.

Pl. VI., figs. 1 a, b, 2 a, b; Pl. VII., fig. 6'.

There are only a few specimens belonging to this species, one of which is a cast of an interior of a moderate size, showing the suture line; the others are smaller, but mostly provided with the shell.

Dimension :—

	(1) Ratio.		(2) Ratio.	
Diameter.	4.5 cm.	100.	8.6 cm.	100.
Height of the last whorl.	2.0 „	44.	4.2 „	48.
Breadth of the last whorl.	1.8 „	40.	4.0 „	46.
Width of umbilicus.	1.35 „	30.	2.1 „	24.

1) A young individual from the Yūbarigawa.

2) The largest specimen from the Ikushumbets.



Shell discoidal, thick; whorls round in the early stage; subquadrate in the adult, higher than broad, and broadest near the umbilical edge. Ventral side uniformly rounded. Umbilicus moderate in size, showing about three fifths of the circumference of each volution and surrounded by a perpendicular wall. Surface ornamented with very fine striae, and also very feeble and narrow furrows. The striae are so fine that we can hardly detect them without the aid of a magnifier; they rise at the umbilical suture, bend abruptly forward at the umbilical edge and then traverse the sides without any further flexion. The faint furrows on the body chamber of the largest specimen are narrow, parallel to the striae, and arranged at intervals of about half a centimeter from one another. The suture line is very complicated, but shows on the whole the character of the group of *G. Sacya* FORBES. There are six or seven saddles on each side; the external, the two lateral and the first auxiliary saddles are symmetrically bifid; the first lateral lobe is the deepest, slightly surpassing the external lobe in depth and also symmetrically bipartite. Auxiliary saddles and lobes hang obliquely toward the umbilical suture.

The fine striae of growth and numerous feeble furrows of the present form make it seem at first sight to be allied to *Pseudophyllites indra* STOLICZKA<sup>1</sup> sp., to which its general aspect also closely conforms. The most characteristic feature of *Pseudophyllites*, however, lies in the suture line of the young shell, which shows tripartite saddles with ptylloid termination, while in individuals of an advanced stage both branches of the external saddle become unequal in size. The Indian form is, therefore, not only different from the Japanese, but also from all other

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1) STOLICZKA: l. c. p. 112, Pl. LVIII, fig. 2.—KOSSMAT: l. c. p. 41 (137), Pl. II. (XVI.), figs. 6 a, b, 9 a, b; Pl. III. (XVII.), figs. 6, 7 a, b; Pl. IV. (XVIII.), fig. 3.

species of *Gaudryceras*. On this account, it was placed by NAUMANN and WHITEAVES in the genus *Phylloceras*,<sup>1)</sup> while KOSSMAT treated it as *Pseudophyllites*,<sup>2)</sup> a new subgenus of *Lytoceras*; but the writer is at present not in a position to advance any opinion on the matter.

In common with the preceding species and *G. Rouvillei* GROSSOUVRE,<sup>3)</sup> *Gaudryceras Yokoyamai* has fine striae traversing the ventral side, bending neither forward nor backward, but running always straight. The small specimens of *G. Yokoyamai* and *G. limatum* are liable to be confounded with one another, but those of the former possess higher whorls and a narrower umbilicus than those of the latter. *G. Rouvillei* from the Santonien of Southern France is too small for a closer comparison, but it seems to be distinguished from the young of the Japanese species by its deeper involution.

Localities and Horizon:—In pebbles from the Yūbarigawa and the Ikushumbets. Found also in the *Pachyliscus*-beds along the Kikumezawa, a left tributary of the Ikushumbets.

### GAUDRYCERAS YAMASHITAI M.

Pl. IV., fig. 7.

Only two immature specimens of this species were found, the larger of which measures:—

Diameter.	8.8 cm.	Ratio. 100.
Height of the last whorl.	4.4 „	50.

1) WHITEAVES: On some Foss. Nanaimo group Vancouver Cret. p. 129.

2) KOSSMAT: l. c. p. 41 (137).

3) GROSSOUVRE: l. c. p. 228, Pl. XXXVII. figs. 7 and 10.

Breadth of the last whorl	3.3 cm.	37.
Width of umbilicus	2.2 „	25.

Shell discoidal, compressed; when young, whorls nearly round, with wide umbilicus; when about 5 cm. in diameter, the whorl enlarges rapidly in height, and is flattened on the sides. Involution about one half or slightly less. The surface of the shell is covered with very fine thread-like striae which are somewhat flexuous. The whorl has neither periodic ribs nor furrows. There are three bipartite saddles and lobes, all of which are finely toothed. The three auxiliary saddles hang obliquely on the umbilical wall.

This Ammonite shows a great resemblance to *G. Yokoyamai*, from which it is distinguished by its compressed, comparatively higher whorls and wider umbilicus. It also approaches *G. limatum*, and appears to have a character intermediate between this species and *G. Yokoyamai*.

Localities:—The Ikushumbets, Prov. Ishikari; the Makka-ushipe, a tributary of the Popet, Prov. Iburi; one from each locality. The figure is that of the smaller specimen from the Makka-ushipe.

Horizon:—Upper Ammonite-beds.

The two species—*G. Yokoyamai* and *G. Yamashitai*, have been described from young individuals, as in the case of *G. politissimum* from South India. Although their full grown specimens are not yet known to the writer, still when judged from their general shape, surface ornamentation and suture line, which are all very peculiar, it is quite certain that they form a special subgroup with *G. limatum* as the type.

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## SUBGROUP OF GAUDRYCERAS SACYA.

## GAUDRYCERAS sp.

The writer has seen only a single fragment of an Ammonite which is referable to the subgroup of *G. Sacya*. This fragment being a part of the body chamber of an adult specimen, nothing can be said about its general shape and suture line. But the surface with narrow flexuous furrows is quite similar to that of *G. Sacya* figured by STOLICZKA<sup>1)</sup> and WHITEAVES.<sup>2)</sup> The space between two successive furrows measures above 1.2 cm., while the furrows themselves measure about 0.3 cm. in breadth on an average on the ventral side: besides there are numerous fine striae covering the entire surface of the shell.

The specimen is too imperfect for exact determination, but its resemblance to *G. Sacya* is so great that there is hardly any doubt of its representing a form closely related to, if not actually identical with that species.

Locality;—A specimen, found in the collection of JIMBŌ, is in a marly nodule from Ishuikarushihara, on the Penkeohoshikep, a branch of the Teshiogawa.

Horizon :—Unknown.

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1) STOLICZKA: l. c. p. 154, Pl. LXXV., fig. 7.

2) WHITEAVES: Mesozoic Fossils. Vol. I. Pl. 3, P. 203, Pl. XXV.

SUBGROUP OF GAUDRYCERAS VARUNA.

**GAUDRYCERAS KAWANOI** JIMBŌ sp.

1894. *Desmoceras Kawanoi* JIMBŌ: l. c. p. 28, Pl. I. (XVII.),  
figs. 7 a, b.

This species is represented by two specimens, one of which belongs to the type described by JIMBŌ. The other slightly deviates from this type, but is considered by the writer as belonging to the same species.

Dimensions :—

	(1)	Ratio.	(2)	Ratio.
Diameter.	2.5 cm.	100.	2.2 cm.	100.
Height of the last whorl.	1.0 „	1.	0.9 „	40.
Breadth of the last whorl.	0.8 „	32.	0.75 „	34.
Width of umbilicus.	0.8 „	32.	0.75 „	34.

1) The type specimen of *Desmoceras Kawanoi* JIMBŌ from Ikandai near Urakawa, Prov. Hidaka.

2) The second specimen from the Bannozawa, a tributary of the Ikushumbets near the Poronai coal-mines, Prov. Ishikari.

The diagnosis of this species given by JIMBŌ is as follows:—

“Schale flach-scheibenförmig. Umgänge schnell an Höhe zunehmend, die grösste Dicke des Umganges in der Mitte. Die Zahl der Umgänge ist ca. 7. Nabel weit. Die Oberfläche ist von äusserst feinen Streifen bedeckt und zeigt 3 schwache Einschnürungen auf der letzten Windung. Die Streifen und Einschnürungen bilden auf der Aussenseite leichte, vorwärts gerichtete Buchten.”

In this diagnosis, the last part needs some alteration. The periodic furrows and numerous fine striae extend obliquely forward from the umbilical suture to the ventral side, without the slightest

trace of a forward prolongation. The cross-section of the whorl is oblong, being broadest in the middle of the lateral side. The umbilicus is of a moderate size, about  $\frac{2}{3}$  of the inner volution being exposed; the umbilical wall gently slopes toward the umbilical suture and to the lateral side.

The suture line shows many lobes on each side, which are finely and deeply incised and diminish in size toward the umbilicus. The external lobe is as deep as the first lateral. The external and the lateral saddles as well as the first lateral lobe are bipartite. Judging from the general aspect of the shell, and especially from the suture line, the present species seems to belong to a particular subgroup of *Gaudryceras*, which contains only three species from foreign Cretaceous, viz., *G. odiense* KOSS. of the lower Utatur group of South India, *G. varuna* FORBES of the Valudayur bed of the same region and *G. anaspatum* REDTENBACHER sp. of the Gossau bed of north-east Alps. Our form is distinguished from *G. odiense* by its broader umbilicus and its lower whorls, from *G. varuna* and *G. anaspatum* by the different form of the whorls. *G. varuna* is a species also found in the Quiriquina bed of Chili.<sup>4)</sup>

Localities :—Chashikots in Ikandai near Urakawa, Prov. Hidaka, and the Bannosawa near the Poronai coal-mines, Prov. Ishikari.

Horizon :—*Pachydiscus*-beds.

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1) KOSSMAT: l. c. p. 33 (129), Pl. IV. (XVIII.), figs. 1 a, b, c; Pl. III. (XVII.), fig. 8.

2) KOSSMAT: l. c. p. 34 (130); p. 65 (161), Pl. II. (XVI), fig. 4 a, b; Pl. III (XVII), fig. 8.

3) REDTENBACHER: l. c. p. 113, Pl. XXVI., fig. 1.

4) STEINMANN: l. c. p. 48, Pl. V., figs. 2 a, b.



**TETRAGONITES** KOSSMAT.

Of the species of *Tetragonites* described in the following lines, three have been already described by JIMBŌ. One of these—*Lytoceras glabrum* JIMBŌ—is considered by KOSSMAT<sup>1)</sup> to belong to his newly established subgenus *Tetragonites*. He states that nothing definite can be said about the other two—viz., *L. crassum*. JIMBŌ and *L. sphaeronotum* JIMBŌ. However, after a careful examination of the types and other specimens the writer has come to the conclusion, that these two should also be brought under the same genus.

**TETRAGONITES GLABRUS** JIMBŌ sp.

Pl. VII., figs. 2 and 5.

1894. *Lytoceras glabrum* JIMBŌ: l. c. p. 34 (180), Pl. VI. (XXII.), figs. 2, 2 a.

1895. *Lytoceras* (*Tetragonites*) *glabrum* KOSSMAT: l. c. p. 133. Dimensions:—

	(1) Ratio.		(2) Ratio.	
Diameter.	3.5 cm.	100.	6.5 cm.	100.
Height of the last whorl.	1.7 "	48.	3.2 "	49.
Breadth of the last whorl.	1.9 "	54.	3.6 "	55.
Width of umbilicus	0.8 "	22.	1.4 "	21.

1) A specimen from the Sanushibe, Prov. Iburī. (Pl. V., fig. 2).

2) A specimen from the Opirashibets, Prov. Teshio.

This and the next species possess very inflated whorls in the later stages of growth, and comparatively a very thin test. There-

1) KOSSMAT: l. c. p. 37 (133).

fore, the outer volution in adult specimens is generally not well preserved, which makes exact measurement very difficult. These two species are closely allied to each other, and if we compare their dimensions, it is quite evident that there is no material difference between them. The coincidence is not only in dimensions, but also in nearly all other characters if we except the periodic ribs. There is a group of Ammonites in which the shell is smooth until it has attained about 7 cm. in diameter, after which a periodic arrest of growth begins to appear, while another group shows periodic ribs from the very beginning; still it not rarely happens that we can not determine which of these two characters is shown by a specimen not in a good state of preservation. However, in spite of the imperfect nature of the type specimens, we can easily see that JIMBŌ's *L. sphaeronotum* is of the first category, while his *L. glabrum* is of the second. It is to be added that the writer is, at present, not quite sure whether the absence of periodic ribs on the inner volutions is sufficient for specific distinction. *Tetragonites epigonus* KOSSMAT,<sup>1)</sup> a closely related species, is stated to be rather variable in the appearance of the ribs, some young individuals showing them typically, while the larger ones are smooth. Although this statement leads us to assume that the ribs are not of much importance in the distinction of species, yet the present case must be considered as somewhat different from the above one. As above stated, in *T. sphaeronotus* the periodic ribs appear after the shell has attained a certain size, while in *T. glabrus* they are already present when the shell is young. Forms intermediate between these two have not yet been found. Therefore the writer

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1) KOSSMAT: l. c. p. 39 (155), Pl. III (XVII), fig. 4,5.

is for the time being compelled to treat the two as specifically distinct, as has already been done by JIMBŌ.

It is necessary to make a few remarks on the internal suture line of *T. glabrus* which was not figured by JIMBŌ. It shows two saddles and the corresponding lobes. The antisiphonal and the lateral lobes are narrow and deep; the two saddles are also slender and of equal height, the inner ending bifid and the outer simple.

The above characters of the internal lobes and saddles, together with those of the external part of the suture line, are exactly what we find in the type of *Tetragonites* and especially in *T. epigonus* which also shows two internal saddles.

Localities:—The upper course of the Ikushumbets, and the Yūbarigawa, both in the Province of Ishikari; the Saushi-sanushibe, a tributary of the Popets in the Prov. Iburi; the Opiraushibets and the branches of its upper course, in the Prov. Teshio. Many specimens from all the localities mentioned.

Horizon:—Upper Ammonite-beds.

# **TETRAGONITES SPHAERONOTUS** JIMBŌ sp.

Pl. VII., figs. I a, b.

1894. *Lytoceras sphaeronotum* JIMBŌ: l. c. p. 35 (181), Pl. VI. (XXII.), figs. 3, 3a.

Dimensions:—

	(1) Ratio.		(2) Ratio.	
Diameter.	14.5 cm.	100.	6.9 cm.	100.
Height of the last whorl.	7.0 „	48.	3.3 „	47.
Breadth of the last whorl.	7.2 „	49.	3.8 „	54.
Width of umbilicus.	3.0 „	20.	1.4 „	20.

1) A specimen from the Opiraushibets, Prov. Teshio.

2) A specimen from the Yūbarigawa, Prov. Ishikari.

Shell thick, discoidal, composed of many whorls; whorls somewhat trapezoidal being laterally flattened, ventrally inflated and slightly broader than high. Umbilicus narrow, deep, with a perpendicular wall and bluntly angular edge. Involution about  $\frac{2}{3}$ . Surface with very fine but distinct striae of growth, without any trace of periodic ribs. The older specimens show whorls more rapidly increasing in height and breadth, and provided with periodic ribs. These ribs are slightly elevated and rounded, corresponding to shallow furrows on the cast of the interior. They are widely separated, there being only two or three in one volution. The fine striae as well as the periodic ribs which are also covered with striae, rise at the umbilical suture, bend obliquely forward on the lateral sides and then backward on the ventral side. Besides there are a few longitudinal lines on the external half of the lateral sides which are visible only on the last half of a volution of the largest specimen in the writer's collection. The periodic ribs begin to appear when the shell attains 7 cm. in diameter.

The length of the body chamber of *Tetragonites* is not yet known. The largest specimen, mentioned above, shows two thirds of the last volution not septate, but as the anterior end of the whorl is broken off, the length of the body chamber must be more than  $\frac{2}{3}$  of a volution.

Suture line as in the preceding species.

There are many well preserved individuals of this species in the writer's collection, one of which is shown in fig. 1, Pl. VII. The above diagnosis was written after a study of them and the two specimens in Jimbō's description essentially agree with them.

Besides these specimens, there are also a somewhat modified form distinguished by a slightly wider umbilicus and compressed whorls. For the present, this is considered only as a variety.

Localities :—The Yūbarigawa ; the Ikushumbets and its branches, the Yoshiashizawa and the Kikumezawa ; between the Motomari and the Chietomanai, Sōyagōri, Prov. Kitami ; Shirutsuruhara, on the left bank of the Teshiogawa ; the Opiraushibets and its tributaries, the Penke-kenebets and the Panke-kenebets, in the Province of Teshio. The figured specimen was found in a pebble from the Yūbarigawa.

Horizon :—Upper Ammonite-beds ; abundant in the *Scaphites*-beds.

### **TETRAGONITES CRASSUS JIMBŌ sp.**

1895. *Lytoceras crassum* JIMBŌ : l. c. p. 35 (181), Pl. VI. (XXII.), fig. 5 a, b.

Whorls nearly round, slightly flattened on the sides and inflated ventrally, broader than high. Umbilicus moderate in size, deep, surrounded by a perpendicular wall. Involution about  $\frac{3}{4}$ . Surface unknown, the only specimen being a cast of an interior. The suture line is shown in JIMBŌ's work. The siphonal saddle, however, is high and trigonal, and not so low or flat at the apex as is shown in his figure. The external as well as the first lateral lobe is asymmetrically bipartite ; besides, there are four auxiliary saddles and corresponding lobes ; the first auxiliary saddle is just at the umbilical edge whence the others incline obliquely downward to the umbilical suture.

JIMBŌ took the shape of the whorl to be the character distinguishing the present species from the preceding. He de-

scribes *T. crassus* as “Windung seitlich nicht abgeplattet” and *T. sphaeronotus* as having “Seitenflächen etwas abgeplattet.”<sup>1)</sup>

The present species being based on a single young specimen represented by an internal cast, the writer is not in a position to draw a distinct line of demarcation between it and *T. sphaeronotus* or *T. glabrus*. However a slight difference in the form of the whorls and the somewhat wider umbilicus of the present species, as compared with the above two, seem to indicate that it belongs to a distinct species.

Locality:—In a pebble from the Pombets, Prov. Ishikari.

Horizon:—Unknown.

### TETRAGONITES POPETENSIS M.

Pl. VII., figs. 4, a, b, and 6.

Dimensions:—

	(1) Ratio.		(2) Ratio.	
Diameter.	3.4 cm.	100.	2.05 cm.	100.
Height of the last whorl.	1.45 „	42.	0.90 „	43.
Breadth of the last whorl.	1.50 „	44.	0.90 „	43.
Width of umbilicus.	1.0 „	30.	0.55 „	26.

1) A specimen from the Shi-sanushibe. (Pl. VII. figs., 4 a, b).

2) A specimen from the Penke-opushikep, a tributary of the Teshiogawa. (Pl. VII., fig. 6.)

Shell discoidal, compressed, the smaller specimens measured above, being composed of five volutions. Umbilicus moderate in size; involution about  $\frac{2}{3}$ . Whorls subquadrate in section, inflated ventrally, and the umbilical wall perpendicular. Surface smooth, with exceedingly fine lines of growth. Periodic arrest of growth

1) JIMES: l. c.



marked only by feeble furrows on the east; about six of them were counted in the smaller specimens. These striæ or lines and furrows are of exactly the same nature as those of the above three species, but project more strongly forward. The suture line shows four saddles on the external side, a saddle and one or two denticles following them on the umbilical wall, and two saddles on the internal side.

In the suture line and the general aspect of the shell, the only species which approaches this is *T. epigonus* KOSSMAT. The suture lines of both species can hardly be distinguished from each other. However, the Japanese form is rather widely umbilicated and its whorls are lower.

Localities :—The Makka-ushipe, a tributary of the Sanushibe, Prov. Iburi; the Penke-opushikep, a tributary of the Teshiogawa, Prov. Teshio. One specimen from each locality. From the Shisanushibe, also a tributary of the Sanushibe, we have three specimens, one of which is figured.

Horizon :—*Pachydiscus*-beds; the horizon at the last mentioned locality has not yet been ascertained.

### **TETRAGONITES** *cfr.* **EPIGONUS** KOSSMAT.

Pl. VII., fig. 3.

Compare :—

1895. *Lytoceras epigonum* KOSSMAT: l. c. p. 39 (135), Pl. III. (XVII.), figs. 4, a, b, c, and 5, a, b.

1865. *Ammonites Timotheanus* p. p. STOLICZKA: l. c. p. 146. Pl. LXXIII., fig. 5.

## Dimensions :—

		Ratio.
Diameter.	3.2 cm.	100.
Height of the last whorl.	1.4 „	43.
Breadth of the last whorl.	1.55 „	48.
Width of umbilicus.	0.90 „	28.

General shape as in *T. sphaeronotus*. Umbilicus moderate in size, surrounded by a perpendicular wall. Involution about  $\frac{2}{3}$ . Whorls rather slowly growing, subquadrate in cross-section, somewhat broader than high and broadest near the umbilical margin. Surface smooth, but with periodic arrest of growth, indicated by inconspicuous round ribs of which four have been counted on the last half of the outer volution. The character of the ribs is the same as in *T. glabrus* and *T. sphaeronotus* being distinguished only by a somewhat more oblique course.

Suture as in the preceding species.

The Japanese specimens agree quite well with those described by KOSSMAT under the name of *T. epigonus* from the upper Trichinopoly group of Andur and Varagur, S. India. The body whorl of the larger Indian specimen figured by KOSSMAT measures 2.6 cm. high and 2.7 cm. broad, and its umbilicus 1.5 cm. in width, the diameter of the shell itself being 5.9 cm. Among the Japanese specimens there is none which attains such a large size. But they are comparable to, and agree in every particular, with the smaller ones of *T. epigonus* also figured by KOSSMAT. The periodic arrest of growth is sometimes entirely absent and sometimes present on the young shells of *T. epigonus*, so that this seems to be of no special importance in the distinction of the species. In the specimens in the writer's collection, the periodic ribs are shown with moderate distinctness and their number agrees with those of the larger specimen figured by KOSSMAT.

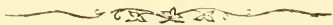
The reason why the writer hesitates to identify the Japanese form with *T. epigonus* lies in the fact that his specimens are all in a young stage, and that there is none which clearly shows the suture line.

Distinguished from *T. popetensis* by the higher and broader whorls and the narrower umbilicus; from *T. sphaeronotus* and *T. glabrus* by the lower whorl and the wider umbilicus. *T. crassus*, on the other hand, is distinguished by its broader whorls.

Localities :—The Penke-kenebets and the Kenekawen-opirau-shibets, both branches of the Opiraushibets, and the Abeshinai, a tributary of the Teshiogawa. Five specimens have been examined.

Horizon :—*Scaphites*-beds.

Foreign Localities of *T. epigonus* :—Upper Trichinopoly group of S. India and Senonian of Tunis.<sup>1)</sup>



1) L. PERVINQUIERE: Sur un faciès particulier du Sénonien du Tunisie. 1898.

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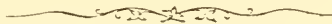
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CRETACEOUS CEPHALOPODA FROM THE HOKKAIDO.

PLATE I.

*Lytoceras.*

**Plate I.**

*Lytoceras ezoëense* m.      Pp. 9-11.

Fig. 1. Side view of the type, preserved in the Sci. Coll. Mus. From lower Ammonite-beds of the Pompets, Prov. Ishikari. Reduced to  $\frac{3}{4}$  nat. size.



*Fig. 1.*





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PLATE II.

Lytoceras.

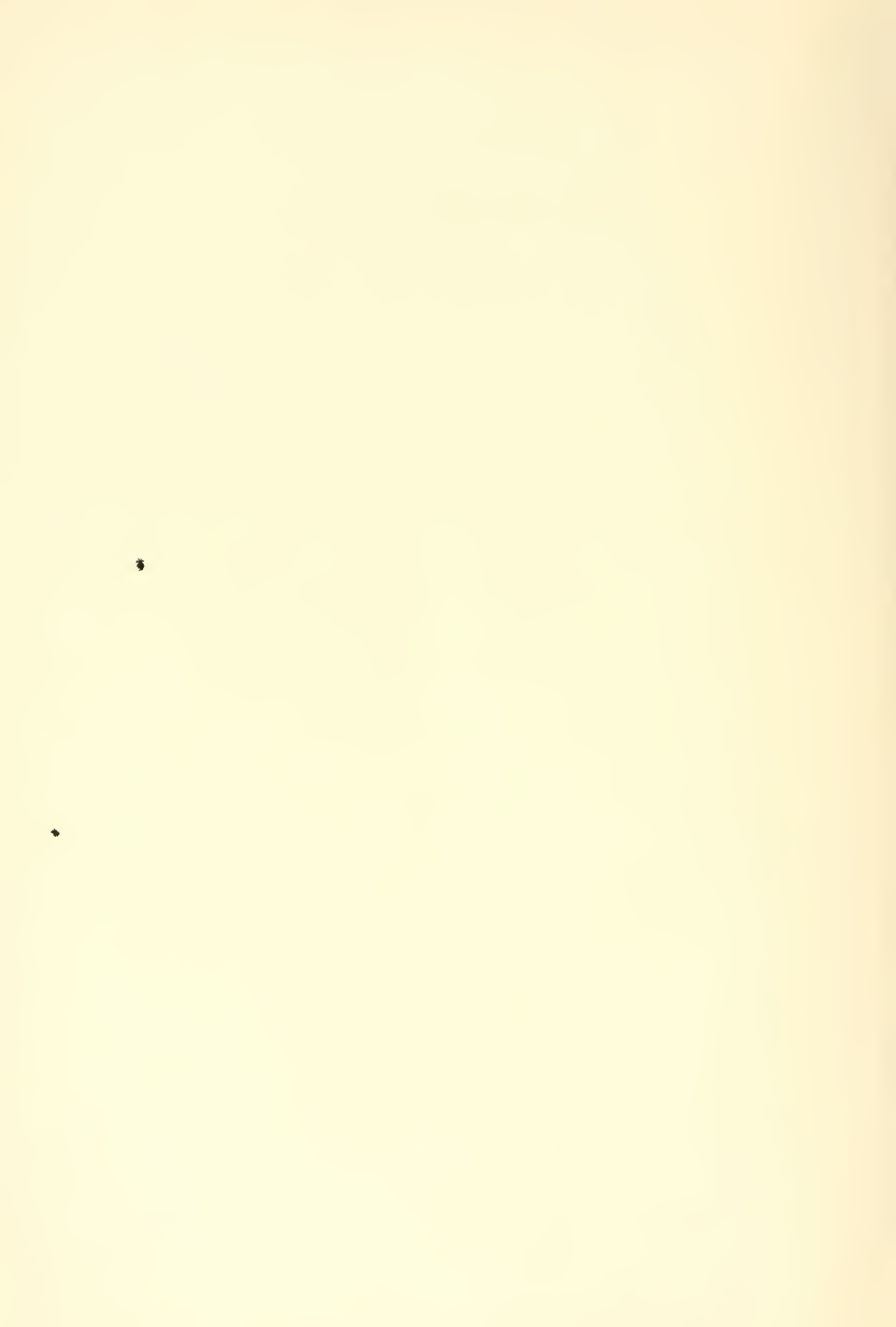
**Plate II.**

*Lytoceras imperiale* m.      Pp. 11-12.

Fig. 1. Side view of the type, preserved in the Sci. Coll. Mus. From lower Ammoite-beds of the Ikushumbets, Prov. Ishikari. Reduced to  $\frac{3}{4}$  nat. size.



*Fig. 1.*



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CRETACEOUS CEPHALOPODA FROM THE HOKKAIDO.

PLATE III.

Gaudryceras.

### Plate III.

*Gaudryceras tenuiliratum* n. Pp. 19-29.

(All the specimens in the Sci. Coll. Mus.).

- Fig. 1. var. *intermedia*. a, side view ; b, front view of a specimen from upper Ammonite-beds of the Sanushibe, Prov. Iburi. Nat. size.
- Fig. 2. var. *ornata*. a, side view ; b, front view of a specimen from *Pachyliscus*-beds of the Kikamezawa, Prov. Ishikari. Nat. size.
- Fig. 3. A part of the suture line of a large specimen of normal type. From *Pachyliscus*-beds of the Bannosawa, Prov. Ishikari. Nat. size.—s., siphonal line.
- Fig. 4. Suture line of a specimen. 3.5 cm. in diam., of normal type. From *Pachyliscus*-beds of the Sanushibe, Prov. Iburi.—s., siphonal line ; um., umbilical margin ; us., umbilical suture.  $2\frac{1}{2} \times$ .





*Fig. 3.*



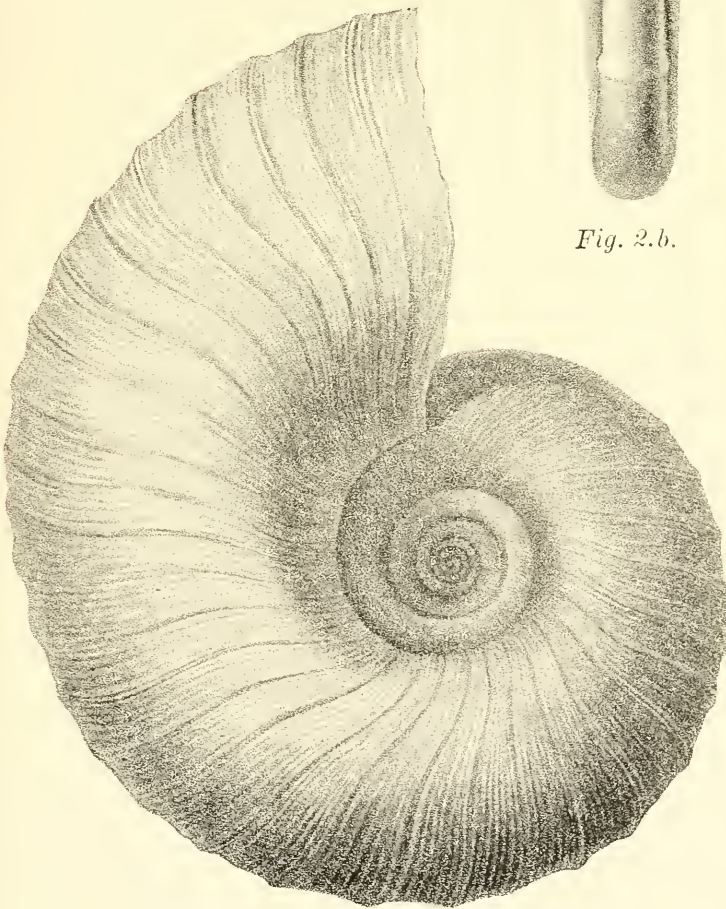
*Fig. 4.*



*Fig. 2.a.*



*Fig. 2.b.*



*Fig. 1.a.*



*Fig 1.b.*



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PLATE IV.

*Lytoceras* and *Gaudryceras*.

## Plate IV.

*Lytoceras imperiale* m. P. 12.

Fig. 1. Suture line, drawn from the specimen figured in Pl. II. Nat. size.—  
s., siphonal line; um., umbilical margin; us., umbilical suture.

*Gaudryceras limatum* m. P. 35.

Fig. 2. Suture line, drawn from the specimen figured in fig. 2, Pl. V.  
Nat. size. Lettering as in fig. 1.

*Gaudryceras tenuiliratum* m. Pp. 28-29.

Fig. 3. var. *infrequens*. a, side view; b, front view of a specimen preserved  
in the Sci. Coll. Mus. From *Scaphites*-beds of the Opirashibets,  
Prov. Iburi. Nat. size.

*Gaudryceras crassicosatum* JIMBŌ sp. Pp. 29-30.

Fig. 4. Side view of a specimen in the Sci. Coll. Mus. From upper  
Ammonite-beds of Cape Sōya, Prov. Kitami. Nat. size.

*Gaudryceras striatum* JIMBŌ sp. Pp. 31-34.

Fig. 5. Side view of a specimen in the Sci. Coll. Mus. From *Pachydiscus*-  
beds of the Abeshinai-rubeshibe, Prov. Teshio. Nat. size.

Fig. 6. var. *picta*. a, side view; b, outline of a transverse section; c,  
surface of a septum, showing the septal lobe, of a specimen in the  
Sci. Coll. Mus. From *Pachydiscus*-beds of the Uipets-rubeshibe,  
Prov. Teshio. Nat. size.

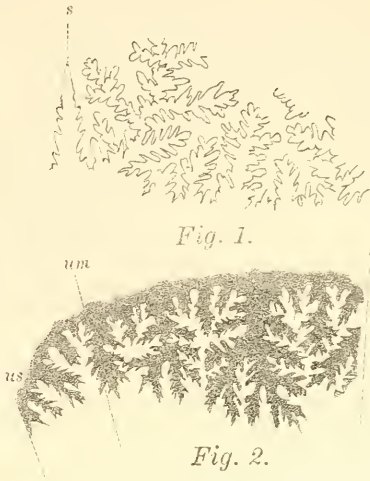
*Gaudryceras Yamashitai* m. Pp. 38-39.

Fig. 7. Side view of the type in the Sci. Coll. Mus. From upper Ammonite-  
beds of the Sannshibe, Prov. Iburi. Nat. size.



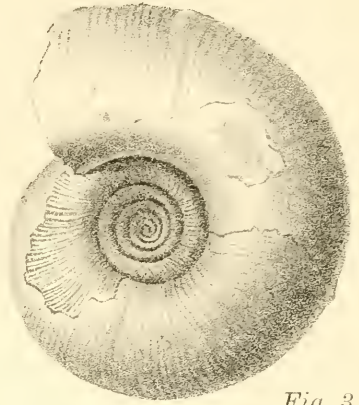


*Fig. 3.b.*

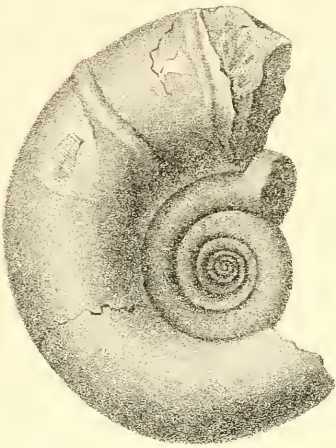


*Fig. 1.*

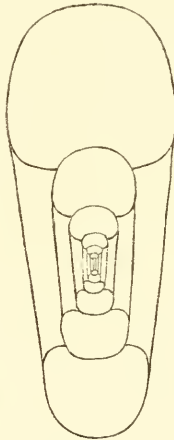
*Fig. 2.*



*Fig. 3.a.*



*Fig. 6.a.*



*Fig. 6.b.*



*Fig. 7.*



*Fig. 4.*



*Fig. 6.c.*



*Fig. 5.*





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PLATE V.

Lytoceras and Gaudryceras.

**Plate V.**

*Lytoceras eccense* m.      P. 10.

Fig. 1. Suture line, drawn from the specimen figured in Pl. I. Nat. size

*Gaulryceras limatum* m.      P. 36.

Fig. 2. Side view of a specimen, preserved in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.



Fig. 1.

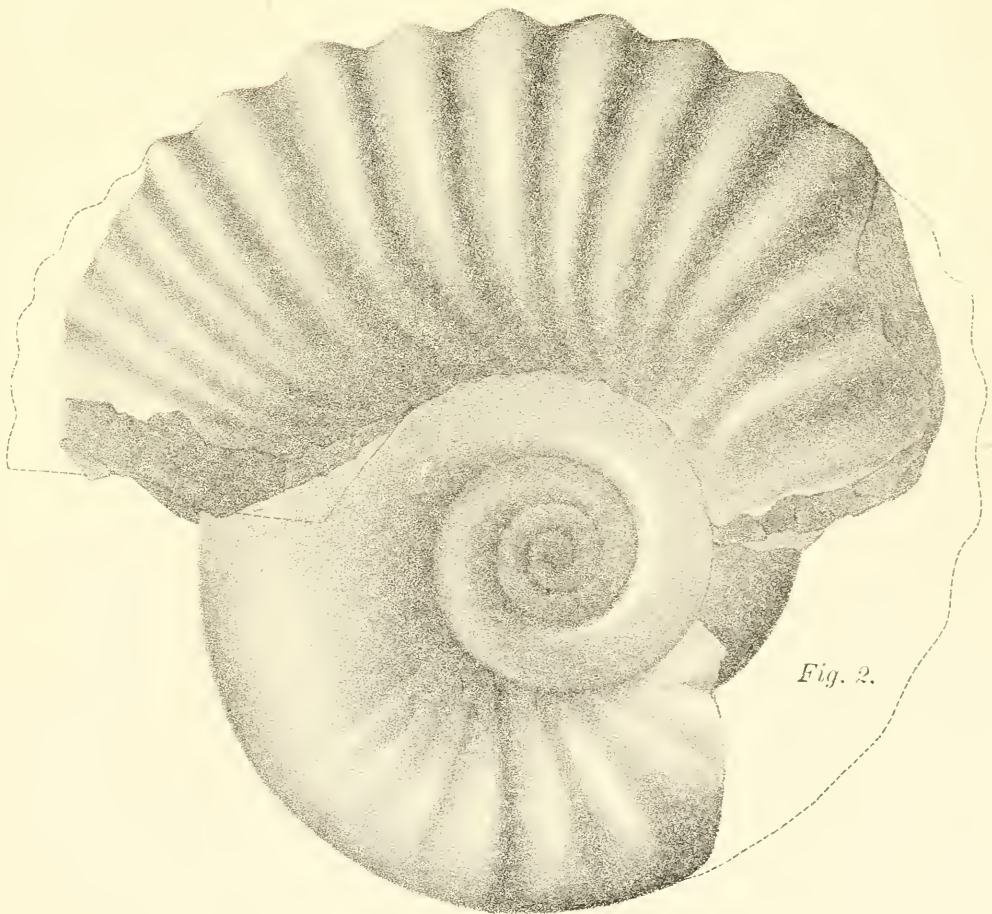


Fig. 2.



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PLATE VI.

Gaudryceras.

## Plate VI.

*Gaudryceras Yokoyamai* m.      Pp. 36-38.

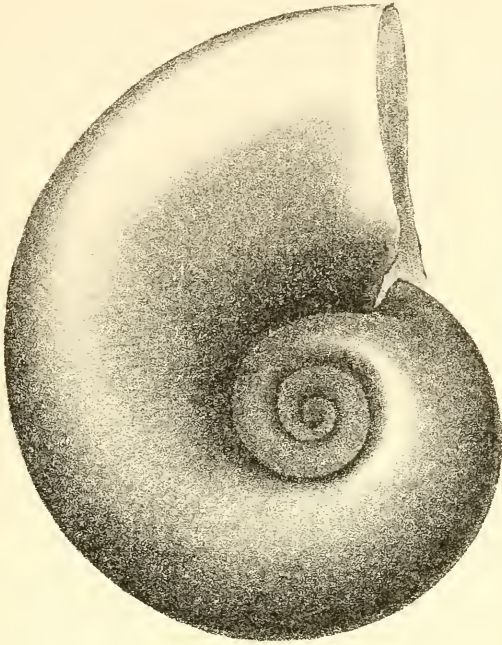
Fig. 1. a and b, side and front views of the type in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.

Fig. 2. a, side view ; b, front view, of a younger specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.

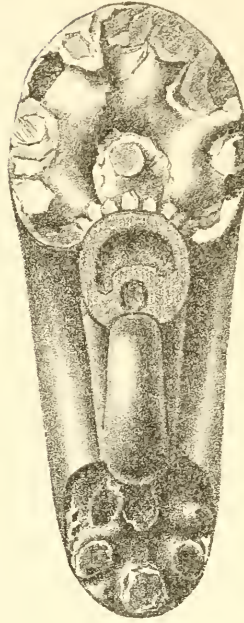
*Gaudryceras limatum* m.      Pp. 34-36.

Fig. 3. a, side view, somewhat restored ; b, front view, of the type in the Sci. Coll. Mus. From upper Ammonite-beds of the Yoshiashizawa, a tributary of the Ikushumbets, Prov. Ishikari. Nat. size.

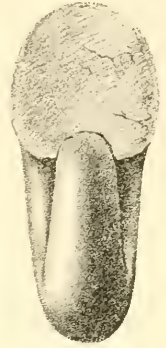




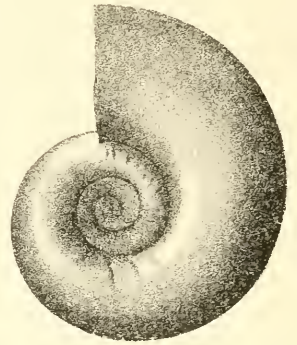
*Fig. 1a.*



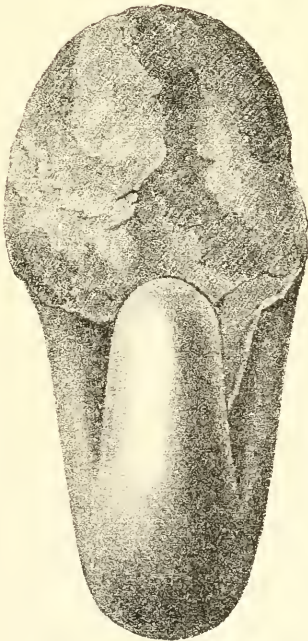
*Fig. 3b.*



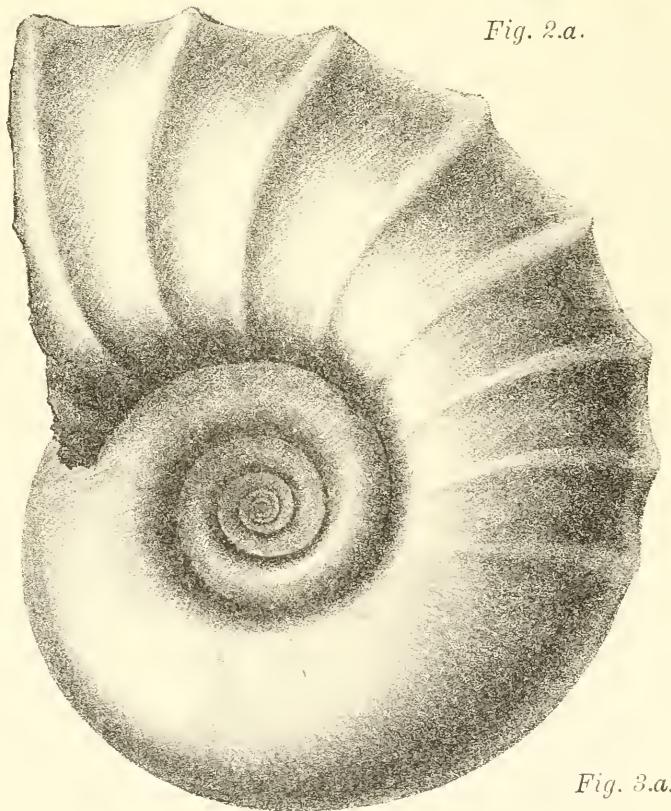
*Fig. 2.b.*



*Fig. 2.a.*



*Fig 1b.*



*Fig. 3.a.*



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CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE VII.

Gaudryceras and Tetragonites.

## Plate VII.

*Tetragonites sphaeronotus* JIMBŌ sp. Pp. 45-47.

Fig. 1. a, and b, side and ventral views of a specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.

*Tetragonites glabrus* JIMBŌ sp. Pp. 43-45.

Fig. 2. Side view of a specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Sanushibe, Prov. Iburi. Nat. size.

Fig. 5. A part of the suture line of the same specimen. Enlarged.

*Tetragonites* cf. *epigonus* KOSSMAT. Pp. 49-51.

Fig. 3. Side view of a specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Kenekawen-opirautshibets, Prov. Teshio. Nat. size.

*Tetragonites popetensis* m. Pp. 48-49.

Fig. 4. a, side view; b, front view, of the type in the Sci. Coll. Mus. From *Pachydiscus*-beds of the Sanushibe, Prov. Iburi. Nat. size.

Fig. 6. Suture line of another specimen in the Sci. Coll. Mus. From *Pachydiscus*-beds of the Penke-opushikep, Prov. Teshio. Enlarged.

*Gaudryceras yokoyamai* m. P. 37.

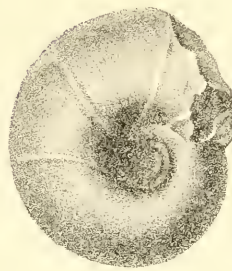
Fig. 6'. Suture line drawn from the specimen figured in Pl. VI., fig. 2. Enlarged.—s., siphonal line; um., umbilical margin; us., umbilical suture; as., antisiphonal line.



*Fig 1.b.*



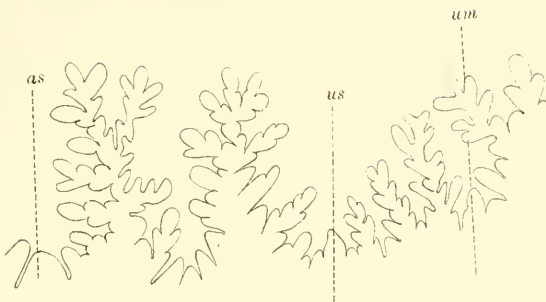
*Fig. 6.*



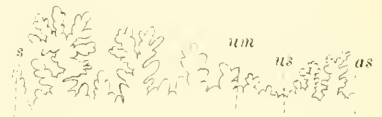
*Fig. 2.*



*Fig. 3.*



*Fig. 5.*



*Fig. 6.*

*Fig. 1.a.*



*a.*



*b.*

*Fig. 4.*





## On the Formation of Anthocyan in the Petaloid Calyx of the Red Japanese Hortense.

By

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---

*With one Plate.*

---

### I. Introduction.

It is well known that the different shades of red and blue observed in vegetable organs are due to the presence of anthocyan<sup>1)</sup> in different stages of its development, the red pigment found, for instance, in the skin of many ripe fruits (*Prunus*, *Pirus*, *Vaccinium*, *Vitis*, etc.), in some young shoots (*Acer*, *Ilex*, *Cinnamomum*, *Asparagus*, etc.), and in various flowers (*Pæonia*, *Pharbitis*, *Phlox*, *Portulacca*, *Celosia*, etc.) being anthocyan in some stage of development.

Very little is known, however, of the chemical nature of anthocyan and, more especially, of the mode of its formation; a fresh investigation in these directions seemed, therefore to be highly desirable. Among the few known reactions of anthocyan

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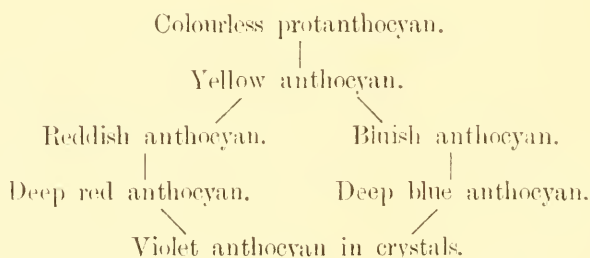
1) Marquart's anthocyan, and Fremy's and Cloëz's cyanin are identical.

may be mentioned the change of its colour from blue to red by the action of acids, this being looked upon as one of its characteristic properties.

Of the physical properties of anthocyan it is known that the red variety shows an absorption band at F and another at the end of G, that the violet variety shows one at D, with a feeble shade toward the green side and another at the end of the spectrum, and that the blue variety shows a broad absorption band beginning soon after D and continuing to F.<sup>1)</sup>

The object of the present work has been to study the formation of anthocyan in vegetable cells and to ascertain the essential conditions under which this pigment is developed. Red Japanese Hortense seemed to offer suitable material for this study, because of the slowness with which anthocyan passes through the different phases of its development in this plant, and also because of the long duration of its blossoming period.

The different phases of the development of anthocyan in the petaloid calyx of Hortense may be briefly sketched out as follows :—



All these colours have been observed under the microscope. The young calyx appears at first slightly greenish to the naked

---

1) Husemann, Th.—Die Pflanzenstoffe. Bd I. p. 259. (After G. Kraus).

eye, but its microscopical structure shows no colour. This green pigment in the epidermal cell-sap is present in such a very small amount that it is hardly recognizable in a thin section. I intend to call anthocyan in this primitive stage colourless protanthocyan; from this yellow anthocyan is next derived. The latter is a true colour-generator. Zopf<sup>1)</sup> studied the developmental phases of anthocyan in Fumariaceæ and observed that a colourless chromogen barely makes its appearance, then frequently a yellow pigment in some species, and lastly red anthocyan. His colourless „Chromogen,“ Wigand's<sup>2)</sup> colourless „Cyanogen“ and my protanthocyan are probably; identical, since they all consist of a certain tannin compound. Moreover, according to Harvey<sup>3)</sup> the development of colour in flowers probably begins with green, which is followed successively by yellow, white and red, and ends with violet or blue. This is almost the same order as that in the case of the formation of anthocyan in red Hortense. How protanthocyan changes into the variously coloured anthocyanes will be more fully discussed later on, but it may here be mentioned that both internal and external influences are active in producing these changes.

Of the existence of the blue or violet crystals of anthocyan, which I have found in the petaloid-calyx of red Hortense in the latest stage, only very little has hitherto known. Probably the „blue star“ in the epithelial cells of the Delphinium petals<sup>4)</sup> and the violet crystals in the epidermal cells of the coffee-berry

---

1) Zopf, W.—Ueber die Gerbstoff und Anthocyan-Behälter der Fumariaceen und einiger anderen Pflanzen. 1886.

2) Wigand.—Einige Sätze über die physiologischen. Bedeutung der Gerbstoffes und Pflanzen. Farbe. (Bot. Ztg. 1862, 122).

3) Harvey, E. W.—Observation on the colour of Flowers. 1899.

4) Cf. Weiss, A.—Anatomie der Pflanze. 1878, p. 130, and Strasburger, Ed.—Das Botanische Practicum 1897, p. 122.

may be allied pigments. Zimmermann<sup>5)</sup> describes the “pigment-secretion” as a certain compound of anthocyan with some unknown tannin substance. According to chemical examinations, however, the violet crystals, which I have observed, proved to be nothing else than those of anthocyan.

In the following pages I shall describe the development of anthocyan in Japanese Hortense in four phases. In Kanazawa, the flowering period of this plant lasts about four months, beginning in June and ending in September. My observations were carried on during the years, 1900 and 1901.

## II. Different Phases of the Development of the Petaloid Calyx.

### THE FIRST PHASE.

Duration of observation : June 1—July 1. *External form.*—At the beginning of June most of the peripheral flower-buds swell and open gradually. (Fig. 1.) Now each young flower nutates upon a curved stalk and already carries four or five involved petaloid calyx-leaves. Among the latter, the one which is the lowest in position is the largest and entirely covers the other. At this stage, particularly in the largest calyx leaf, the predominance of hyponastic growth can be traced, but, later, epinastic growth becomes the more powerful. Soon afterward, each curved flower stalk tends to stand erect and the flower itself to open. Even in full bloom, each calyx-leaf, remains to the last phase without losing its spoon shape.

5) Zimmermann, A.—Die Botanische Mikrotechnik. 1892, p. 104.

When the flowers open the petaloid calyx appears not absolutely white but yellowish or slightly greenish, fading from the base towards the end. However, this colour is not due to the presence of chlorophyll, but to the slightly yellowish cell-sap. At this stage protanthocyan is already formed and distributed equally over the calyx-leaf by centrifugal propagation. (Fig. 2.) After undergoing some morphological and metabolic changes from external influences (especially sunlight) the calyx becomes glossy white and red anthocyan now begins to appear.

*Microscopical Structure.*—On cross section the upper and the lower epidermal cells show a similar flat form and hold from four to ten mesophyll (chlorophyllless) cell-layers between them. The mesophyll layer consists of more or less irregular, loosely united cells, in intercellular space and contains crystals of calcium oxalate. Crystals of irregular shape are very abundant in the mesophyll and in the hypodermal parts. Some raphides occur in the middle part of mesophyll.

Looked at from above, the upper epidermal cells show less wavy outlines than the lower, and both are furnished with indistinct cuticular striations. The lower epidermal cells are provided with many stomata and deciduous unicellular hairs, which are covered with thick cuticular spots. The latter are entirely wanting on the upper side. In this phase each cell in the calyx-leaf contains besides protoplasm nothing but slightly yellow sap, and the whole tissue is very clear. At a later period this yellowish sap becomes much more conspicuous and is confined to both epidermal cells. (Fig. 11.). This is the stage at which protanthocyan passes into yellow anthocyan, the chemical reactions of which are given in the following table I.

Table I.

	Reagents.	Reactions of colourless or slightly yellowish anthocyan. (= prot-anthocyan).
Acids.	Hydrochloric acid.	No reaction (slightly red).
	Nitric acid.	"
	Sulphuric acid.	Yellow (all through).
	Acetic acid.	No reaction.
	Phosphoric acid.	"
	Salicylic acid.	"
	Tartaric acid.	"
Alkalis and Salts.	Ammonia.	Yellow.
	Caustic potash.	"
	Caustic soda.	"
	Lead acetate.	Yellow precipitate.
	Sodium carbonate.	Slightly yellow.
	Potassium bichromate.	Reddish brown precipitate (not all).
	Ferrie chloride	Black (deep green) precipitate.
	Ferrie chloride + potassium ferrocyanide.	Deep blue precipitate.
	Ferrous sulphate.	No remarkable reaction.
	Silver nitrate.	Brown precipitate.
	Millon's reagent.	Browish yellow.
	Iodine in potassium iodide.	No reaction.
	Quinine sulphate.	"
	Potassium cyanide.	Yellow.
	Flemming's solution.	No reaction.
	Chloral hydrate.	"
	× Naphtol + sulphuric Acid.	(Mesophyll violet).
	Alum.	Yellowish orange.
	Antipyrine.	No. reaction.
	Caffeine.	"

From these chemical reactions protanthocyan and yellow anthocyan may probably be considered as some allied compounds of tannin or modified phenol compounds, as Pfeffer<sup>1)</sup> remarks. Indeed I have often detected a substance like protanthocyan in the epithelial cells of white flower petals of many other plants,

1) Pfeffer.—Pflanzen Physiologie. Bd. I. 1897, p. 493.



but this substance never develops later on into any coloured anthocyan. Now the question arises why in certain flowers protanthocyan precedes a coloured anthocyan while in some others it does not. The answer is to be sought, probably, in the hereditary disposition of each plant.

That the colourless protanthocyan becomes yellow by the action of alkalis, as stated in preceding table, is worth noticing, for it proves the presence of a tannin substance, as Wiesner<sup>1)</sup> observed. The change of the colour of yellow anthocyan, when well developed, to a light red by the action of acids, is also of some interest. Moreover, the existence of intercellular air-spaces and the exceedingly abundant presence of the crystals of calcium oxalate at this stage is worth remarking.

#### THE SECOND PHASE.

Duration of observation: July 1—July 20. *External form.*—Each white calyx-leaf of the opened flowers now begins to colour, by the appearance of red spots from the distal end of its upper side. The colour proceeds along the margin centripetally over the surface (Fig. 3.4). In general, this propagation of colour occurs earlier on the larger calyx-leaf than on the smaller one, though at the end the whole upper surface becomes coloured, except the borders of the veins. For this development of colour it is necessary that the calyx should be exposed directly to the sunlight, the overlapped part of the upper side of a calyx-leaf and also the whole lower side being not at all tinged till the end of this phase.

---

1) Wiesner, J.—Einige Beobachtungen über Gerb- und Farbstoffe der Blumenblätter. (Bot. Zeitg, 1862, p. 389).

*Microscopical structure.*—It is noticeable that the epidermal cells of the upper side become much projected upwards, assuming the shape of a cap, whilst those of the lower side remain unchanged. The glossy-white appearance of the calyx-leaf which is observed at first is chiefly due to the abundant presence of air in the intercellular space and partly also to the reflection of light by the cap-shaped projection of the epidermal cells. Later, many epidermal cells containing red anthocyan, besides those containing the yellow variety, are found on the upper side, whilst on the lower side coloured anthocyan has not yet made its appearance. The microscopical study of the calyx-leaf of red Hortense certainly reminds one of that of the flower-petals of several other plants.

The cuticular radiating striations of the upper side become, finally, very distinct and the paralld striations of the lower side, commonest in epidermal cells of all plants, also become visible.

The air-spaces and the crystals of calcium oxalate show a tendency to gradually decrease and are mostly concentrated toward the hypodermal layers.

The chemical reactions of red anthocyan are shown in Table II.

Table II.

	Reagents.	Reactions of red anthocyan.
Acids.	Hydrochloric acid.	No reaction.
	Nitric acid.	Yellow.
	Sulphuric acid.	Yellowish brown.
	Acetic acid.	No reaction.
	Phosphoric acid.	"
	Salicylic acid.	"
	Tartaric acid.	"

Alkalis and Salts.	Ammonia.	Yellowish green.
	Caustic potash.	Green.
	Caustic soda.	"
	Lead acetate.	Green precipitate.
	Sodium carbonate.	Yellow (contracts into globular mass).
	Potassium carbonate.	Green ( " " " " " ).
	Potassium bichromate.	Deep blue precipitate.
	Ferric chloride.	Black (deep blue) precipitate.
	Ferric chloride + potassium ferrocyanide.	Deep blue precipitate.
	Ferrous sulphate.	No reaction.
	Silver nitrate.	Brown precipitate.
	Millon's reagent.	Brownish yellow.
	Iodine in potassium iodide.	No reaction (contracts into a globular mass).
	Quinine sulphate.	No reaction.
	Potassium cyanide.	Violet yellow.
	Flemming's solution.	Violet, dark blue, brown.
	Chloral hydrate.	Dissolves out.
	α Naphtol + sulphuric acid.	Brown.
	Alum.	No reaction.
	Antipyrine.	"
	Caffeine.	"

Looking over the table it will be seen, in general, that acids do not produce any marked change in the colour of the red anthocyan but that alkalis change it into green. The presence of sugar in the mesophyll layer remains doubtful. Chlorophyll-grains have not yet appeared.

### THE THIRD PHASE.

Duration of observation: July 20—August 1.

*External form.*—The majority of the flowers of red Hortense now tend to nutate around their stalks, though some of them are not yet wholly reddened on the upper side of the calyx. Each calyx-leaf becomes turned upside down. This process which is

physiologically produced by the epinastic growth of the flower stalk may from a biological point of view be described as a phenomenon of "gamotropism."<sup>1)</sup> Being exposed directly to the sunlight, the lower side of the calyx, now in an uppermost position, turns red beginning at the base and ending at the periphery in a way just opposite to that observed in the case of the upper side. The red colour on the lower side is not so bright as it is on the upper side, but is rather dark except at the veinal surface (Fig. 7.). Besides, the darkness of the red colour is increased with the concentration of the spot and with the appearance of green chlorophyllgrains. In the meantime, all parts of the calyx-leaf on both sides, hitherto whitish, become noticeably green (Fig. 7,8.).

*Microscopical structure.*—On the upper side the number of red coloured epidermal cells and the intensity of the red colour are both gradually increased. Some slightly blue cells are often met with in the hypodermal layer. On the other hand, the red cells on the lower side are mainly observable in its hypodermal layer consisting of idioblastic irregular cells, but partly also in its epidermal layer, the cells of which mostly remain colourless. Such colouration of the hypodermal cells may be characteristic of the calyx-leaf of Japanese Hortense, for it is not usually found in the flower-petals or petaloid calices of other plants, which contain anthocyan. The multipolar horns of the idioblastic cells of the entire mesophyll layer gradually become prominent and, at the same time, the layer appears more spongy, the intercellular spaces being more conspicuous. In the normally healthy state (i.e. when not diseased or injured) the red idioblasts are confined to the hypodermal layer and never go any deeper. This condition

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1) Ludwig, Fr.—Lehrbuch der Biologie der Pflanzen. 1835, § 74.

differs greatly from that of the autumnal red colouration of leaves.

Crystals of calcium oxalate decrease still more than in the preceding phase. Some raphides are rarely found in the middle part of the mesophyll layer.

Chlorophyll-grains begin to appear, at first, in both hypodermal cells and later extend toward the middle of the mesophyll. The formation of starch, accompanying the chlorophyll-grains, is soon afterwards observed. That chlorophyll-grains appear later than red anthocyan has been noticed by former investigators<sup>1)</sup> in many cases, and this fact is no doubt to be explained from a teleological point of view.

The chemical reactions of deep red and blue anthocyan are given in Table III.

Table III.

	Reagents.	Reactions of deep red anthocyan.	Reactions of blue anthocyan.
Acids.	Hydrochloric.	No reaction.	Red.
	Nitric.	"	"
	Sulphuric.	"	Red, brown, yellow.
	Acetic.	"	Red.
	Phosphoric.	" (contracts into a globular mass).	"
	Salicylic.	"	"
	Tartaric.	"	"
Alkalis. and Salts.	Ammonia.	Deep green (blackish).	Green.
	Caustic potash.	Green (then yellow).	Green (soon afterward yellow).

1) Pick, Bedeutung des rothen Farbstoffs bei Phanerogamen. (Bot. Cent. Blatt. Bd. 16, p. 281, 1883). Kerner, Pflanzen Leben. 2. Aufl. Bd. I. p. 470. Stahl, Annales du Jardin Botanique de Buitenzorg. Vol. XIII. p. 137-216, 1896.

Lead acetate.	Deep green precipitate.	Green (precipitate?)
Sodium carbonate.	Dark green (contracts into a globular mass).	Greenish yellow.
Potassium carbonate.	Black (deep green) (contracts into a globular mass).	„
Potassium bichromate.	No reaction.	Slightly red.
Ferrie chloride.	Black precipitate.	Momentarily red, then black.
Ferrie chloride + potassium ferrocyanide.	Deep blue precipitate.	Momentarily red, then black and blue precipitate.
Ferrons sulphate.	No reaction.	No reaction.
Silver nitrate.	„ (Violet, brown, dark).	„ (slightly brown).
Millon's reagent.	Reddish brown precipitate, (later dark brown).	Momentarily red and then reddish brown.
Iodine in potassium iodide.	No reaction (contracts into a globular mass).	No reaction (slightly black).
Quinine sulphate.	Violet, green, yellow, (granules dissolve later).	Violet, green, yellow. (granules dissolve later).
Potassium cyanide.	Green, yellow (contracts into a globular mass).	Slight green, yellow.
Flemming's solution.	Violet, then black, brownish yellow.	Momentarily red, then slightly black, brownish yellow.
Chloral hydrate.	No reaction.	No reaction.
α Naphtol + sulphuric acid.	Dissolves.	Slightly red (dissolves).
Alum.	No reaction (slightly violet).	No reaction.
Antipyrine.	No reaction.	„
Caffeine.	„	„

Here the presence of sugar mostly around the fibro-vascular bundle of the calyx-leaf can be demonstrated.

#### THE FOURTH OR LAST PHASE.

Duration of observation : August 1—September 1.

*External form.*—Flowers standing erect can no longer be found. The calyx-leaves nutate and are soon reddened on the



lower side. A very quick and remarkable development of red anthocyan on some injured parts of the calyx-leaf is particularly noticeable, and is most apparent on the upper greenish side. (Fig. 9.). This phenomenon is in entire agreement with the observations made by Linsbauer, Ludwig and Molisch. Now when the red colour of the lower side attains its maximum, it appears as a somewhat dark red, whilst on the veinal surface it is a rather distinctly crimson red. This dark red colouration is chiefly due to the mixing of the epidermal deep red, and the hypodermal blue, anthocyan. (Fig. 10.).

In the course of the process of the degeneration of the calyx-leaf the interveinal mesophyll parts become dark brownish, then gradually dry up with the decrease of the sap, and finally die out. After the removal of the destroyed mesophyll parts there still remains the brownish skeletal vein-net of the calyx-leaf. This dead calyx-net is not deciduous till the spring of the next year.

*Microscopical structure.*—Both red and blue anthocyan now become much more concentrated in all the cell-sap. Nevertheless, the colouring matter is still to be found in some cases in its various younger stages—colourless, yellowish and of a pale red. In this phase it is worth noticing that violet or bluish crystals and refractive globules appear in the outer layers of the calyx-leaf. (Fig. 12.).

Many of the violet crystals appear granular and measure about  $5\mu$  on the average. Some of them have the form of a needle shaped prism,  $7-9\mu$  long. They are found in the hypodermal or epidermal cells on both sides of the calyx-leaf. Their chemical reactions completely agree with those of the blue or violet cell-sap, and hence these crystals must be regarded as

those of anthocyan. (Fig. 14). They dissolve in hydrochloric, acetic, and other acids to form a red solution. With sulphuric acid, however, no sooner are they dissolved, than they reappear as red brownish amorphous granules. Potash dissolves them into a pale green solution, whilst chloral hydrate dissolves them without any special change of colour. They are, no doubt, identical with Zimmermann's "pigment secretion" and Krømer's<sup>1)</sup> "violet chromatophore," which are generally considered as some tannin compounds of anthocyan. Hitherto the crystal form of anthocyan in a living cell has been but little known. Besides the two writers above named, Husemann<sup>2)</sup> had enumerated the plants in which "pigment corpuscles" (Farbkörper) occur. Strasburger's "blue star," consisting of short needles of crystallized anthocyan, is found in many cells of the blue coloured calyx-leaf of the *Delphinium*-flower. It is identical with Zimmermann's "pigment secretion."

A peculiar body, the so-called refractive globule, is found constantly in this last phase within each epidermal cell of the calyx-leaf of the Japanese *Hortense*. (Fig. 13.). It appears, at first, as numerous fine drops around a nucleus, which gradually unite into one large refractive globule, measuring  $4-5\ \mu$ . It is stained by alkannin, coloured a light brown by sulphuric acid, and is insoluble in alcohol, hydrochloric and acetic acids. This body closely resembles Krømer's "strong refractive globules" found in the coffee-berry, and only differs from it in being almost insoluble in chloral hydrate and alcohol (5:2). Aqueous ammonia produces no reaction with it. Probably it may be a certain

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1) Krømer, K.—Ueber das angebliche Vorkommen von violetten Chromatophoren. (Bot. Cent. Blatt. Nr. 41. Bd LXXXIV. 1900).

2) Husemann, Th.—Die Pflanzenstoffe. 1882, Bd I, p. 259.

protein substance combined with some fatty bodies. It is different from oil drops.<sup>1)</sup>

Chlorophyll-grains increase much in the mesophyll and, later, starch-grains of large size appear in abundance; soon afterward the chlorophyll-grains begin to degenerate.

Crystals of calcium oxalate decrease remarkably in amount and tend to disappear. Raphides, though very few, remain unchanged.

### III. SUMMARY.

1). When anthocyan has completed its development, chlorophyll-grains begin to appear in the mesophyll layer of the calyx and, at a later period, deposit a large amount of starch-grains.

2). After the appearance of the red colouration on the upper side, the flower-stalk nutates downward to expose its lower side directly to the sunlight. In this position, the lower side also assumes a reddish tinge.

3). The flower remains open for about four months in summer, and the calyx-leaf is persistent throughout this period.

4). Protanthocyan from which yellow, red, deep red, or bluish anthocyan and also bluish violet crystals are derived, consists of a certain colourless tannin compound.

5). Protanthocyan becomes yellow or green by alkalis.

6). In the red Hortense, the blue colour appears later than the red, and bluish crystals are often met with within reddish or purple cell-sap. Such variations as is well known depend on the different degrees of acidity.

7). The essential factors which bring about the change of

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1) Rywosch, S.—Einiges über ein in den grünen Zellen vorkommendes Oel und seine Beziehung zur Herbstfärbung des Laubes. (Ber. Deutsch. Bot. Ges. 1897. p. 195).

protanthocyan into a coloured anthocyan in the red Hortense seem to be:—

a). Sunlight.—Those calyx-leaves which are situated in the shade or are overlapped by others never become red. An exceptional case of rare occurrence in which the formation of anthocyan is independent of sunlight was observed by Zopf in the root of *Parnassia palustris*. Also the red pigment which occurs in such an underground organ as the sweet-potato or the red raddish seems to have little need of sunlight for its formation.

b). Acidity.—It has been generally ascertained by previous observers that the red pigment can not exist without an acid cell-sap in the living state.

The crystals of calcium oxalate with the aid of intercellular air-spaces may serve as a protecting medium to the delicate young calyx-leaf against strong sunlight, as they reflect the light and hinder a too speedy transpiration. Schimper<sup>1)</sup> states that leaves which have grown in the full sunshine are richer in crystals of calcium oxalate than those grown in the shade. But the calyx-leaf differs from ordinary green leaves in this respect, since these crystals are formed before chlorophyll granules appear.

c). Tannin and sugar.—Many observations render it probable that the mother substance of anthocyan is a peculiar tannin matter. The calyx-leaf of the red Hortense, however, never produces red anthocyan in the absence of sunlight, though it contains tannin. The root of *Parietaria diffusa* produces red anthocyan only in its tannin idioblasts. Hence some plants appear to require light more than tannin, and others tannin more than light, for the development of anthocyan.

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1) Schimper, A. F. W.—Ueber Kalkoxalatbildung in dem Laubblätter. (Bot. Zeitg. 1888, p. 83).

The presence of sugar in the calyx-leaf of *Hortense* is observed only in the earlier phases of its development. Sugar may have no close connection with the formation of anthocyan.

d). Mechanical injury.—Mechanical stimuli hasten the formation of red anthocyan from protanthocyan. When the calyx surface is scratched with a nail, the injured part in a few days becomes much more intensely red than the healthy part. (Fig. 9). This test is effective only in the later stages of the growth of the calyx-leaf. It is already known that any diseased or injured part of leaves or fruit may easily develop red anthocyan, and Molisch<sup>1)</sup> has recently observed a sudden development of a carmin red pigment on making a nail-scratch on the surface of a leaf of *Schenckia blumenaviana*. Ludwig and Linsbauer<sup>2)</sup> also noticed the formation of coloured anthocyan under the influence of mechanical injury.

e). Soil.—The formation of anthocyan in the calyx of *Hortense* is probably more or less influenced by the nature of the soil. Schübler,<sup>3)</sup> Darwin,<sup>4)</sup> Molish,<sup>5)</sup> Miyoshi<sup>6)</sup> and others all ascertained that the colours of the anthocyan of *Hydrangea*-flowers are much influenced by the chemical nature of the soil. DARWIN observed that alum directly influences the colour of *Hydrangea*-

1) Molisch, H.—Ueber ein neues, einen carminrothen Farbstoff erzeugendes Chromogen bei *Schenckia blumenaviana*, K. Sch. (Ber. Deutsch. Bot. Ges. Bd. XIX. Heft 3).

2) Linsbauer, Ludwig.—Einige Bemerkungen über Anthocyanbildung. (Oesterreichische Bot. Zeitg. Jahrg. LI. 1901).

3) Schübler.—Untersuchung einer Erde welche die Eigenschaft hatte, die gewöhnlich rothblühende *Hortensia speciosa* blau zu färben. (Schweigger's und Meineke's Jahrb. d. Chem. u. Physik, 1821).

4) Darwin, C.—The variation of animals and plants under domestication. Vol. II, p. 267. (from the Journal of Hort. Soc., Vol. i, p. 160).

5) Molisch H.—Der Einfluss des Bodens auf die Blütenfarbe der Hortensien. (Bot. Zeitg. 1897. p. 58).

6) Miyoshi, M.—Ueber künstliche Aenderung der Blütenfarben. (Bot. Cent. Blatt. Bd. LXXXIII. No. 11. p. 345).

flowers. The chemical process that occurs in the conversion of protanthocyan into coloured anthocyan is, however, not yet cleared up.

In conclusion, I wish to express my obligations to Prof. Miyoshi for his helpful advice during the course of my investigation.

March, 1902, Fourth High School, Kanazawa, Japan.



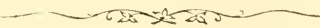


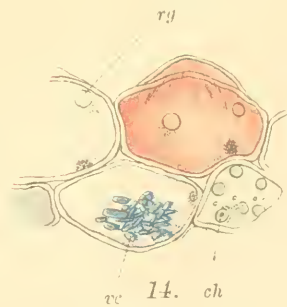
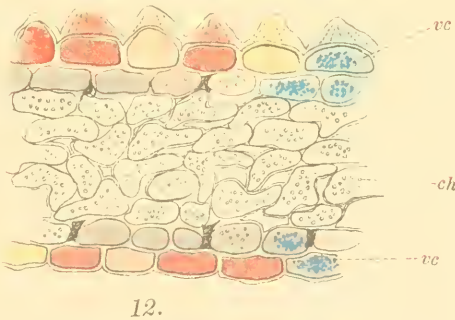
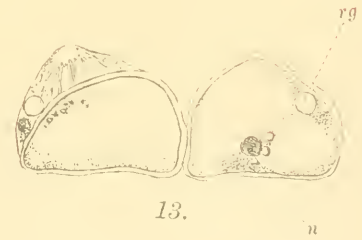
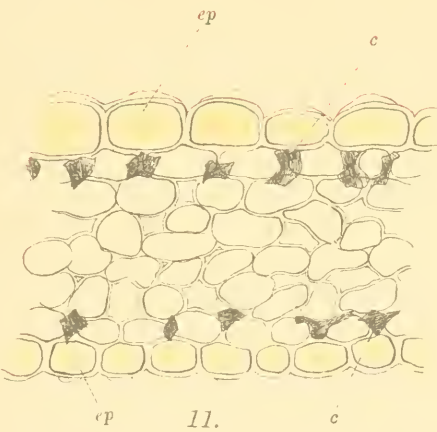
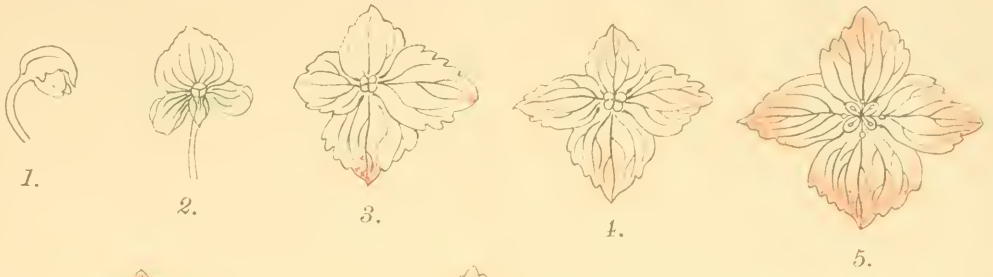
T. ICHIMURA.

ON THE FORMATION OF ANTHOCYAN IN THE PETALOID CALYX OF THE  
RED JAPANESE HORTENSE.

PLATE.

### Explanation of Figures.

- 1-10. Different stages of the formation of anthocyan in the petaloid calyx of the red Japanese Hortense, approximately in natural size.
1. Young state of the flower.
2. A little later stage of the flower.
- 3, 4, 5. Progressive appearance of anthocyan from the peripheral end of the calyx in a centripetal way.
6. Red colouration of the upper side of the calyx, with the exception of some overlapped parts and immediate vicinity of the veins. Most of the flowers begin to nutate at stages of figs. 5-6.
7. The lower side of the calyx of a somewhat dull red colour.
8. The same (only one leaf), much more advanced.
9. The upper side of the calyx, on which red anthocyan has only slightly developed but which has been remarkably reddened on the mechanically injured parts.
10. Maximum degree of anthocyan development on the lower side.
11. Cross-section of the calyx-leaf at a little later stage than that in fig. 2.  $\times 420$ .  
ep. Epidermal cells enclosing protanthocyan.  
e. Crystals of calcium oxalate found in intercellular air-spaces of hypodermal parts.
12. Ditto, in the same stage as that in fig. 8, showing the fully developed state of anthocyan on the upper and the lower side.  $\times 325$ .  
ch. Well formed chlorophyll-grains.  
v. c. Bluish violet crystals of anthocyan.
13. Epidermal cells of the upper side of the same, strongly magnified, showing their minute contents.  $\times 925$ .  
n. Nucleus.  
rg. Refractive globules.
14. Epidermal and hypodermal cells of the upper side of the same.  $\times 925$ .  
v. c. Violet crystals.  
ch. Chlorophyll-grains.
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## On the Comparative Anatomy of the Cucurbitaceæ, Wild and Cultivated, in Japan.<sup>1)</sup>

By

Atsushi Yasuda, *Rigakushi*.

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With Plates I.-V.

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### Introductory and Historical.

The anatomical characters of the Cucurbitaceæ having long attracted the attention of botanists, and the special structures of various organs having been investigated and described by them, I shall begin this essay by giving a brief *résumé* of the work that has thus far been done. LESTIBONDOIS<sup>2)</sup> investigated the arrangement and distribution of the fibro-vascular bundles in the root of *Cucurbita Pepo* and in the stem of *Cucumis Melo*, describing at the same time the relation of the bundles in the stem to those of the leaf in the latter plant. VAN TIEGHEM<sup>3)</sup> made an anatomical study of the roots of *Luffa*, *Lagenaria*, and *Cucurbita*. DUTAILLY<sup>4)</sup> observed the course of the fibro-vascular bundles in the

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1) Compare A. YASUDA. Preliminary Note on the Comparative Anatomy of Cucurbitaceæ, Wild and Cultivated in Japan. Botanical Magazine, Tokyo. 1901. Vol. XV. No. 173.

2) TH. LESTIBONDOIS. Étude sur l'anatomie et la physiologie des végétaux. Lille 1840.

3) PH. VAN TIEGHEM. Mémoire sur la racine. Paris 1872.

4) G. DUTAILLY. Recherches anatomiques et organogéniques sur les Cucurbitacées. Congrès de Montpier. 1879.

Cucurbitaceæ, including that of the leaf-traces and of the bundles in the leaves themselves. A further investigation was conducted by LOTAR,<sup>1)</sup> who compared the structures of the stems, hypocotyls, leaves, tendrils, roots, and seeds of many genera in this family, such as *Citrullus*, *Lagenaria*, *Luffa*, *Coccinea*, *Cucumis*, *Cucurbita*, *Cyclanthera*, *Sicyos*, *Momordica*, *Abobra*, *Rhynchocharpa*, *Bryonia*, *Ecballium*, and *Thladiantha*. In his essay he described in great detail the distribution of the fibro-vascular bundles, with accompanying diagrammatic figures. FISCHER<sup>2)</sup> examined the arrangement of the sieve-tubes in the stems of several genera, and classified them under four heads: (a) vascular-bundle sieve-tubes, (b) ectocyclic sieve-tubes, (c) entocyclic sieve-tubes, and (d) commissural sieve-tubes.

He also referred to the mode of distribution of the sieve-tube system, and described six distinct types: (i.) *Alsomitra* type, (ii.) *Luffa* type, (iii.) *Bryonia* type, (iv.) *Cyclanthera* type, (v.) *Lagenaria* type, and (vi.) *Cucurbita* type. PENZIG<sup>3)</sup> observed in the epidermal cells on the under surface of the leaves of *Momordica echinata* and *M. Charantia*, globular cystoliths which, he found, occurred in groups, radiating from a common centre. In regard to tendrils WARMING,<sup>4)</sup> DUTAILLY,<sup>5)</sup> COGNIAUX,<sup>6)</sup> MÜLLER,<sup>7)</sup> and

1) HENRI-AIMÉ LOTAR. Essai sur l'anatomie comparée des organes végétatifs et des téguments séminaux des Cucurbitacées. Lille 1881.

2) A. FISCHER. Untersuchungen über das Siebröhrensystem der Cucurbitaceen. Bot. Centralbl. 1885. Bd. XXI. No. 4.

3) O. PENZIG. Zur Verbreitung der Cystolithen im Pflanzenreich. Bot. centralbl. 1881. Bl. VIII. No. 13.

4) E. WARMING. Verzweigungsverhältnisse der Phanerogamen. Königl. deutsch. Acad. der Wissenschaft. 1877.

5) G. DUTAILLY. Recherches organogéniques sur les formations axillaires chez les Cucurbitacées. Association française pour l'avancement des sciences. Congrès de Harure. 1877.

6) A. COGNIAUX. Cucurbitaceen in DE CANDOLLE'S Monographie Phanerogamarum. 1881. Vol. III.

7) E. G. O. MÜLLER. Untersuchungen über die Ranken der Cucurbitaceen. COHN'S Beiträge zur Biologie der Pflanzen. 1886. Bd. IV. Heft 2.



others came to the conclusion, that the main axis of the tendril corresponds to a branch, which carries several leaves. The testa has been investigated by BISCHOFF,<sup>1)</sup> STRANDMARK,<sup>2)</sup> HÖHNEL,<sup>3)</sup> FICKEL,<sup>4)</sup> GODFRIN,<sup>5)</sup> HARTWICH,<sup>6)</sup> and HARZ.<sup>7)</sup> According to HÖHNEL the testa consists of ten layers of cells, of which the first layer arises from the epidermis of the carpel; the second, the swollen epidermis, is made up of prismatic cells with thickened-ridges on their walls, and together with the following three layers is derived from the outer integument of the ovule; the third consists of irregular cells, abounding in intercellular spaces; the fourth, of large stone-cells; the fifth, of reticulate cells with many intercellular spaces; the sixth, of compressed cells derived from the inner integument of the ovule; the seventh originates from the epidermis of the nucellus; the eighth, from the perisperm; the ninth and the tenth, from the endosperm.

So far the chief results of investigations hitherto made concerning the anatomy of the Cucurbitaceæ; for my part, I have tried to examine and compare the internal structures of various organs of those Cucurbitaceæ which are found wild or are cultivated in Japan. The number of our known genera belonging to this family is fifteen: namely, *Actinostemma*, *Melothria* *Mukia*,<sup>8)</sup>

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1) G. W. BISCHOFF. Handbuch der botanischen Terminologie und Systemkunde. Nürnberg 1833. Bd. I.

2) J. E. STRANDMARK. Bau der Samenschale. JUST's Bot. Jahresber. 1874. Bd. II.

3) F. v. HÖHNEL. Morphologische Untersuchungen über die Samenschale der Cucurbitaceen. Wien 1876.

4) J. F. FICKEL. Ueber die Anatomie und Entwicklungsgeschichte der Samenschalen einiger Cucurbitaceen. Bot. Ztg., 1876. Bd. XXXIV. Nr. 47-50.

5) J. GODFRIN. Étude histologique sur les téguments séminaux des Angiospermes. Paris 1880.

6) C. HARTWICH. Ueber die Samenschale der Coloquinthe. Archiv. der Pharm. 1882. Bd. CCXX.

7) C. D. HARZ. Landwirtschaftliche Samenkunde. 1885. Bd. II.

8) H. KUROIWA. A List of Phanerogams collected in the Southern Part of Okinawa, an island of the Loochoo Chain. Botanical Magazine, Tokyo. 1900. Vol. XIV. No. 163. p. 123.

*Zehneria*,<sup>1)</sup> *Schizopepon*, *Momordica*, *Luffa*, *Citrullus*, *Cucumis*, *Bryonopsis*,<sup>2)</sup> *Benincasa*, *Lagenaria*, *Trichosanthes*, *Cucurbita*, and *Gymnostemma*. Of these I have examined twelve genera, leaving for a future occasion the study of *Mukia*, *Zehneria*, and *Bryonopsis*, which are at present unfortunately inaccessible to me.

I have studied the anatomical characters of the stems, hypocotyls, blades, petioles, cotyledons, tendrils, roots, fruits, and seeds of the following sixteen species: *Actinostemma racemosum* Maxim., *Melothria japonica* Maxim., *Schizopepon bryoniaefolius* Maxim., var. *japonicus* Cogn., *Momordica charantia* L., *Luffa cylindrica* (L.) Roem., *L. acutangula* (L.) Roxb., *Citrullus vulgaris* Schrad., *Cucumis sativus* L., *C. Melo* L., *Benincasa cerifera* Savi., *Lagenaria vulgaris* Ser., *Trichosanthes cucumeroides* Maxim., *T. japonica* Regel., *T. multiloba* Miq., *Cucurbita Pepo* L., and *Gymnostemma cissoides* Fr. et Sav. Whenever it has appeared necessary, old as well as young specimens have been examined and compared. In the present paper I shall treat the subject in nine chapters, to be followed with a summary of the chief results of my investigation. Here I wish to express my hearty thanks to Prof. Dr. J. MASTUMURA of the Imperial University, of Tokyo, under whose care my investigations have been conducted. My thanks are due also to Mr. Y. TANAKA, Dr. K. MIYABE, Mr. T. MAKINO and Mr. T. YOSHINAGA, all of whom have kindly supplied me with valuable materials for study.



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1) H. KUROIWA, *loc. cit.* p. 123.

2) *Ibid.* p. 123.

## CHAPTER I.

## THE STEM.

*Contour.* In the Cucurbitaceæ the contour of a transverse section through the stem differs considerably in different species and varies even in one and the same individual according to its age. When young the outline of the stem is pentagonal, but becomes more or less roundish as the stems grows older. The stems of *Benincasa cerifera* and *Lagenaria vulgaris* are especially remarkable for a secondarily produced process in the furrows. Generally speaking, young stems are solid, but in advanced age some stems acquire a wide lumen in the centre, and the formation of a narrow compressed cavity is common in the very old stems of many species. In *Benincasa cerifera* (Pl. I. fig. 1-4), *Lagenaria vulgaris*, and *Cucurbita Pepo*, when the stems are still young, a remarkable roundish hollow is already formed in the centre by a gradual splitting of the central tissue.

The full-grown stems of *Luffa cylindrica* and *L. acutangula* as well as the old stems of *Momordica charantia* and *Actinostemma racemosum* have sharply ridged angles. Microscopical examination shows that the ridges of *Luffa cylindrica* (Pl. II. Fig. 35) and *L. acutangula* consist only of outgrowths of the collenchyma, while those of *Momordica charantia* (Pl. II. Fig. 36) and *Actinostemma racemosum*, in spite of their resemblance to the former in external appearance, are formed by newly developed secondary fibro-vascular bundles, which have originated from the

secondary meristem outside of the outer ring<sup>1)</sup> of the vascular bundles.

*Stomata.* The stomata on the stems generally lie in the same plane with the adjoining epidermal cells, but they are sometimes elevated with the epidermis above the surface of the latter, appearing as if they were supported by a short thick hair. *Cucurbita Pepo*, *Benincasa cerifera*, *Lagenaria vulgaris* (Pl. II. Fig. 34), *Luffa cylindrica*, and *Trichosanthes cucumeroides* give good examples of the elevated stomata.

The average numbers of stomata on a square millimetre of the stems of the Cucurbitaceæ in question are as follows :

<i>Trichosanthes cucumeroides</i>	23
<i>T. japonica</i>	23
<i>T. multiloba</i>	22
<i>Citrullus vulgaris</i>	22
<i>Cucurbita Pepo</i>	21
<i>Actinostemma racemosum</i>	20
<i>Lagenaria vulgaris</i>	18
<i>Cucumis Melo</i>	18
<i>Momordica charantia</i>	17
<i>Luffa cylindrica</i>	16
<i>L. acutangula</i>	16
<i>Benincasa cerifera</i>	15
<i>Cucumis sativus</i>	14
<i>Melothria japonica</i>	12
<i>Schizopepon bryoniaefolius</i> var. <i>japonicus</i>	8
<i>Gymnostemma cissoides</i>	7

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1) The fibro-vascular bundles in the stems of the Cucurbitaceæ are arranged in two circles, outer and inner, each of which contains five bundles.

**Trichomes.** The trichomes on the stems are multicellular in every case, and may be divided into four classes: (i.) sharp-pointed conical trichomes, (ii.) blunt-ended conical trichomes, (iii.) short-stalked glandular trichomes, and (iv.) long-stalked glandular trichomes. The first kind is found in *Melothria japonica* (Pl. I. Fig. 5), *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, and *Cucurbita Pepo*; the second, in *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus* (Pl. I. Fig. 6), *Momordica charantia*, *Luffa cylindrica*, *L. acutangula*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*; the third, which has an oval head composed of several cells, in all species without exception; the fourth, which has an oval head consisting of one or more cells, in *Momordica charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus* (Pl. I. Fig. 8), *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Cucurbita Pepo*. Among these the trichome of *Benincasa cerifera* is especially characterized by having two processes at the apex (Pl. I. Fig. 9); that of *Trichosanthes cucumeroides*, by having a single enlarged terminal cell (Pl. I. Fig. 10), and that of *Cucurbita Pepo*, by having the head consisting of two cells, one placed above the other (Pl. I. Fig. 11).

**Cuticle.** The cuticle on the stems is mostly thin and smooth. As exceptions, however, are to be noted *Actinostemma racemosum* and *Gymnostemma cissoides*, the former of which has the cuticle striated at the angled portions, while the latter has it so on all surfaces.

**Collenchyma.** The collenchyma is developed at the angles

of the stems, and often in the furrows between the angles. For example, *Actinostemma racemosum*, *Melothria japonica*, *Momordica charantia*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides* have the collenchyma developed only at the angles; while *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, and *Cucurbita Pepo* have it at the angles as well as in the furrows. The number of groups of collenchymatous cells developed in the furrows varies from two to five. *Cucumis sativus* and *C. Melo* have only traces of this tissue in each furrow; *Luffa cylindrica* and *L. acutangula* have two masses of it; *Citrullus vulgaris* and *Benincasa cerifera*, three masses; and *Cucurbita Pepo*, five masses.

The layers of the collenchymatous cells are much thicker at the angles than in the furrows. Their maximum number (sixteen) is found in the angled portions of the stem of *Luffa cylindrica*, while their minimum number (one) is found in the furrowed portions of the stem of *Cucumis Melo*.

**Sclerenchyma.** In young stems the sclerenchyma forms a ring,<sup>1)</sup> but when the stems become old the ring breaks up into several sections, so that the latter are placed outward of each fibro-vascular bundle. In some old stems the sclerenchyma is also formed inside of the inner phloëm. In other stems a secondarily formed sclerenchyma is developed within the primary one. The secondary sclerenchymatous cells are short and thick-walled, manifesting many pore-canals; while the primary ones are long and fibre-like.

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1) E. G. O. MÜLLER. Cucurbitaceen in ENGLER und PRANTL's die natürlichen Pflanzenfamilien. 1894. Th. IV, Abt. 5, p. 3.



The old stems of some species have only one group of sclerenchymatous cells outside of each fibro-vascular bundle, as in *Actinostemma racemosum*, *Melothria japonica*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Citrullus vulgaris*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*; some have two sclerenchyma masses tangentially arranged, which have been formed by a rupture of the original continuous ring, as in *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, and *Cucurbita Pepo*. There is a remarkable development of secondary sclerenchyma in the very old stems of *Actinostemma racemosum*, *Melothria japonica*, *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*. In *Momordica Charantia* and *Actinostemma racemosum* it is especially noticeable, that the sclerenchyma at the angled portions has a double arrangement, one mass lying just outside a primary fibro-vascular bundle of the outer ring, and the other lying outside a newly formed secondary bundle<sup>1)</sup> which is placed externally to the primary one. In the old stems of *Trichosanthes cucumeroides*, *T. japonica*, and *T. multiloba* the secondary sclerenchymatous cells or stone-cells are developed in great masses and form an incomplete ring around the stem.

**Fibro-vascular Bundles.** The fibro-vascular bundles in the stems are arranged in two rings, the outer and the inner. Each ring contains five bundles, the members of one ring being situated alternately to those of the other. The fibro-vascular bundles of the outer ring are smaller and nearly equally-developed, but those

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1) See below.

of the inner ring often grow irregularly, and in some cases one or two of them are wanting. The old stems of *Momordica Charantia* and *Actinostemma racemosum* present a characteristic arrangement of the fibro-vascular bundles. We may observe double bundles overlapping one another at the angled portions; i.e., the secondary bundles grow outside of the primary ones from a secondary meristem, so that the angled portions are raised into keels.

(a) *Phloëm*. The fibro-vascular bundles are of a bicollateral type, so they have two kinds of phloëm, the peripheral and the axial, of which the former is always better-developed than the latter.

Sieve-tubes occur not only in the phloëm but also outside of it. They are, according to FISCHER,<sup>1)</sup> classified under four heads: (i.) vascular-bundle sieve-tubes, which are found in the phloëm; (ii.) ectocyclic sieve-tubes, between the epidermis and the sclerenchymatous ring; (iii.) entocyclic sieve-tubes, within sclerenchymatous ring; (iv.) commissural sieve-tubes, serving to connect the other kinds of sieve-tubes with one another.

In reference to the mode of distribution of these four kinds of sieve-tubes we may distinguish three types in the Cucurbitaceæ: the first type has the vascular-bundle and entocyclic sieve-tubes, but no ectocyclic or commissural ones; the second has the vascular-bundle, entocyclic and commissural sieve-tubes, but lacks the ectocyclic tubes; the third has the vascular-bundle, ectocyclic, entocyclic, and commissural sieve-tubes. To the first type belong *Luffa cylindrica* and *L. acutangula*; to the second, *Actinostemma racemosum*, *Melothria japonica*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes*

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1) A. FISCHER. *loc. cit.* p. 104.

*cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*; to the third, *Cucurbita Pepo*.

The size of the sieve-tubes is so large that it serves as a distinctive character to the family. The following numbers denote the diameters of the large sieve-tubes in the stems of each species:

<i>Luffa acutangula</i>	0.088 mm.
<i>Cucurbita Pepo</i>	0.088 „
<i>Luffa cylindrica</i>	0.087 „
<i>Trichosanthes japonica</i>	0.085 „
<i>Benincasa cerifera</i>	0.080 „
<i>Lagenaria vulgaris</i>	0.075 „
<i>Momordica Charantia</i>	0.075 „
<i>Trichosanthes multiloba</i>	0.070 „
<i>T. cucumeroides</i>	0.070 „
<i>Citrullus vulgaris</i>	0.065 „
<i>Cucumis Melo</i>	0.065 „
<i>C. sativus</i>	0.065 „
<i>Schizopepon bryoniaefolius</i> , var. <i>japonicus</i>	0.054 „
<i>Actinostemma racemosum</i>	0.045 „
<i>Gymnostemma cissoides</i>	0.040 „
<i>Melothria japonica</i>	0.040 „

(b) *Xylem*. Among the characteristic features of the xylem vessels the following are to be noticed. They are very well-developed and become especially noticeable as the stems advance in age, when they can be easily perceived even with the naked eye. As a rule thyloses<sup>1)</sup> are developed in old vessels. By comparing the diameters of the large vessels in each species the following average measurements were obtained:

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1) H. A. LOTAR. *loc. cit.* p. 30.

<i>Luffa acutangula</i>	0.50 mm.
<i>Lagenaria vulgaris</i>	0.50 „
<i>Cucurbita Pepo</i>	0.48 „
<i>Benincasa cerifera</i>	0.48 „
<i>Luffa cylindrica</i>	0.46 „
<i>Trichosanthes japonica</i>	0.45 „
<i>Momordica Charantia</i>	0.43 „
<i>Trichosanthes cucumeroides</i>	0.32 „
<i>Citrullus vulgaris</i>	0.31 „
<i>Trichosanthes multiloba</i>	0.30 „
<i>Cucumis Melo</i>	0.25 „
<i>C. sativus</i>	0.24 „
<i>Schizopepon bryoniaefolius</i> , var. <i>japonicus</i>	0.23 „
<i>Gymnostemma cissoides</i>	0.22 „
<i>Actinostemma racemosum</i>	0.17 „
<i>Melothria japonica</i>	0.14 „

**Periderm.** In the very old stems of many species periderm is often formed, but in none is it so well developed as in *Trichosanthes cucumeroides*, *T. japonica*, and *T. multiloba*. The periderm originates from phellogen, which has been formed on the outside of the sclerenchymatous sheath.

**Starch-grains and Crystals.** Although some species contain reserve starch-grains in the full-grown stems, yet most species first accumulate them in the old stems, where they are reserved chiefly in the medullary rays. The stems of *Gymnostemma cissoides* and *Actinostemma racemosum* contain reserve starch-grains from a comparatively early age.

The diameters of the large starch-grains stored in the stems of many species are as follows :

<i>Gymnostemma cissoides</i>	0.040 mm.
<i>Melothria japonica</i>	0.025 „
<i>Trichosanthes multiloba</i>	0.017 „
<i>T. cucumeroides</i>	0.017 „
<i>Cucurbita Pepo</i>	0.015 „
<i>Luffa cylindrica</i>	0.015 „
<i>L. acutangula</i>	0.015 „
<i>Trichosanthes japonica</i>	0.013 „
<i>Actinostemma racemosum</i>	0.013 „
<i>Citrullus vulgaris</i>	0.012 „
<i>Cucumis Melo</i>	0.012 „
<i>C. sativus</i>	0.012 „

The stems of *Schizopepon bryoniifolius*, var. *japonicus*, *Momordica Charantia*, *Benincasa cerifera*, and *Lagenaria vulgaris* contain no reserve starch-grains that are appreciable.

Crystals of calcium oxalate are found in the old stems of *Momordica charantia*, *Trichosanthes cucumeroides*, *Luffa cylindrica*, *L. acutangula*, *Lagenaria vulgaris*, *Benincasa cerifera*, *Cucumis sativus*, *C. Melo*, *Schizopepon bryoniifolius*, var. *japonicus*, etc. Of these *Momordica Charantia* has an abundance of the large crystals displaying various forms belonging to the quadratic system.

**Rhizomes.** Rhizomes occur in *Melothria japonica* and *Gymnostemma cissoides*. In both cases, they have scales at each node which, when completely developed, are three in number, and are to be anatomically distinguished as a shoot, a leaf, and a tendril : for, the first has ten fibro-vascular bundles; the second, five bundles with a semi-circular contour; and the third, three or four bundles

with a circular contour;—all which structures characterize the above organs of *Melothria japonica* and *Gymnostemma cissoïdes* as such respectively.<sup>1)</sup> The rhizomes serve as a reservoir of food-materials, so that though other parts of the plants perish with the approach of winter they preserve their life till the next spring, when the young plants grow from the rudimentary scales destined to be the shoots; thus *Melothria japonica* (Pl. II. Fig. 37) and *Gymnostemma cissoïdes* lead a perennial life by means of their subterranean stems.

Generally speaking, the anatomical structures of the rhizomes follow the type of the terrestrial stems, but in particulars they differ widely from the latter. The collenchyma is reduced to a trace, or can be no longer distinguished as such. In *Melothria japonica* a very small group of the delicate sclerenchymatous cells is found only on the outside of each fibro-vascular bundle of the outer ring, while in *Gymnostemma cissoïdes* the degeneration is not so great as in *Melothria japonica*; the sclerenchymatous cells composed of 2-5 layers, extending outside of each fibro-vascular bundle of the outer as well as of the inner rings.

The fibro-vascular bundles in the rhizomes show great degeneration. The sieve-tubes and the vessels are much smaller than those of the terrestrial stems. The following are the diameters of the large sieve-tubes and vessels in the rhizomes of *Melothria japonica* and *Gymnostemma cissoïdes*:

	Sieve-tube,	Vessel,
<i>Melothria japonica</i>	0.032 mm.	0.07 mm.
<i>Gymnostemma cissoïdes</i>	0.031 „	0.12 „ ;

from which we see that the degeneration is much greater in *Melothria japonica* than in *Gymnostemma cissoïdes*.

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1) Compare p. 9, p. 20, and p. 33.



The parenchymatous cells in the rhizomes are remarkably large as compared with those of the ordinary stems on account of their reserved starch-grains. On the epidermis of the rhizomes stomata and trichomes are also sometimes found.

The large starch-grains found in the rhizomes are of the following sizes :

	Diameter.
<i>Gymnostemma cissoides</i>	0.060 mm.
<i>Melothria japonica</i>	0.034 „

Those of the former plant (Pl. II. Fig. 38) are the largest among the starch-grains contained in any organs of the Cucurbitaceæ.



## CHAPTER II.

### THE HYPOCOTYL.

The germinating plantlets of the Cucurbitaceæ have long terrestrial hypocotyls or very short subterranean hypocotyls. *Actinostemma racemosum*, *Melothria japonica*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, and *Cucurbita Pepo*, have the former kind ; while *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*, have the latter.

**Contour.** As seen in a transverse section the contour of the

hypocotyl may be (a) roundish, (b) roundish with a central hollow, (c) square, and (d) square with a central hollow. The first is found in *Actinostemma racemosum*, *Melothria japonica*, *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoïdes*; the second, in *Benincasa cerifera*, *Lagenaria vulgaris*, and *Cucurbita Pepo*; the third, in *Cucumis sativus*; and the fourth, in *Cucumis Melo*.

**Stomata.** The average numbers of the stomata on the surface of the hypocotyl are as follows. They are entirely wanting in the species having the under-ground hypocotyls.

<i>Luffa cylindrica</i>	36 per sq. mm.
<i>L. acutangula</i>	32     „
<i>Citrullus vulgaris</i>	26     „
<i>Cucurbita Pepo</i>	24     „
<i>Cucumis Melo</i>	20     „
<i>Benincasa cerifera</i>	19     „
<i>Lagenaria vulgaris</i>	14     „
<i>Cucumis sativus</i>	8     „
<i>Actinostemma racemosum</i>	7     „
<i>Melothria japonica</i>	6     „
<i>Momordica charantia</i>	0     „
<i>Trichosanthes cucumeroides</i>	0     „
<i>T. japonica</i>	0     „
<i>T. multiloba</i>	0     „
<i>Gymnostemma cissoïdes</i>	0     „

**Trichomes.** Some species bear many trichomes on the hypocotyl, while others have only a small number of them or none

at all. The hypocotyls of *Melothria japonica*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, and *Cucurbita Pepo*, are hairy; those of *Actinostemma racemosum*, *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, and *Citrullus vulgaris*, are nearly smooth; those of *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides*, are entirely naked. The trichomes on the hypocotyl may be divided into the same four classes as those on the stem.

**Collenchyma.** In all species the collenchyma is developed so as to entirely surround the hypocotyl without interruption.

**Sclerenchyma.** The sclerenchyma of the hypocotyl presents a characteristic arrangement; it forms a small mass on the outside of each fibro-vascular bundle.

**Fibro-vascular Bundles.** The number of the fibro-vascular bundles in the hypocotyl is generally smaller than that in the stem. The typical number is six, a median and two angular bundles<sup>1)</sup> being symmetrically situated opposite each cotyledon. Exceptions are however found in *Citrullus vulgaris* and *Cucurbita Pepo*, the former of which has twelve bundles, while the latter has ten.



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1) H. A. LOTAR. *loc. cit.* p. 14.

## CHAPTER III.

## THE BLADE.

*Epidermis.* When viewed from the surface the outlines of the epidermal cells of the blades are straight or wavy: the former is the case on the upper surface and the latter on the lower, except in *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia*, *Lagenaria vulgaris*, *Trichosanthes japonica*, *T. multiloba* and *Gymnostemma cissoides*, where the walls of the epidermal cells on the upper surface are also wavy.

The size of epidermal cells of the blades is greatest in *Gymnostemma cissoides*, the average diameter reaching 0.07 mm., while in those of the remaining species it is 0.03–0.04 mm.

The epidermal cells on the upper surface of the blade of *Trichosanthes cucumeroides* are very characteristic; they are raised into conical papillæ pointing outwards (Pl. III. Fig. 39).

In certain places on the under surface of the blade of *Cucurbita Pepo* the epidermal cells are two or three-layered, and these places consequently assume a somewhat etiolated appearance (Pl. III. Fig. 42).

The epidermis on the under-side of the blade of *Momordica Charantia* is characterized by having many enlarged cells, each of which contains a globular cystolith<sup>1)</sup> (Pl. III. Fig. 40). *Momordica Charantia* is the only species among the plants we have studied, which contains cystoliths. They are fixed to a lateral wall; not, as we see in *Ficus*, *Morus* and *Zelkova*, to the outer wall. The epidermal cells which contain the cystoliths are

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1) O. PENZIG. *loc. cit.* p. 393.

united into groups, radiating from a common centre, as the surface view of the epidermis will clearly show. Each group of these enlarged epidermal cells consists of two or more cells with the cystoliths arranged head to head, as many as eleven of these having been counted. The diameter of a large cystolith is 0.065 mm.

*Stomata.* The number of stomata on the upper and lower surfaces of the blade differs remarkably in each species. The following are the average numbers of stomata found on the upper surface :

<i>Cucumis sativus</i>	160 per sq. mm.
<i>C. Melo</i>	156 „
<i>Cucurbita Pepo</i>	146 „
<i>Benincasa cerifera</i>	112 „
<i>Citrullus vulgaris</i>	100 „
<i>Lagenaria vulgaris</i>	84 „
<i>Luffa cylindrica</i>	76 „
<i>L. acutangula</i>	72 „
<i>Trichosanthes cucumeroides</i>	66 „
<i>Actinostemma racemosum</i>	59 „
<i>Melothria japonica</i>	9 „
<i>Momordica Charantia</i>	0† „
<i>Trichosanthes japonica</i>	0† „
<i>T. multiloba</i>	0† „
<i>Schizopepon bryoniaefolius</i> , var.	
<i>japonicus</i>	0 „
<i>Gymnostemma cissoides</i>	0 „

As can be seen from the above table *Momordica Charantia*

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† Stomata rarely occur.

rarely has stomata on the upper surface of the blade; *Trichosanthes japonica* and *T. multiloba* have them; still more rarely, in the neighbourhood of the veins; and *Schizopepon bryoniifolius*, var. *japonicus* and *Gymnostemma cissoides* have none at all.

In all species the under-surface of the blades has greater number of stomata. The following show the average numbers of them on the under-surface:

<i>Cucurbita Pepo</i>	347 per sq. mm.
<i>Benincasa cerifera</i>	344 „
<i>Cucumis Melo</i>	331 „
<i>C. sativus</i>	324 „
<i>Trichosanthes cucumeroides</i>	310 „
<i>Lagenaria vulgaris</i>	298 „
<i>Citrullus vulgaris</i>	297 „
<i>Trichosanthes japonica</i>	288 „
<i>T. multiloba</i>	276 „
<i>Luffa cylindrica</i>	221 „
<i>L. acutangula</i>	220 „
<i>Momordica Charantia</i>	211 „
<i>Schizopepon bryoniifolius</i> , var.	
<i>japonicus</i>	200 „
<i>Melothria japonica</i>	172 „
<i>Actinostemma racemosum</i>	168 „
<i>Gymnostemma cissoides</i>	91 „

**Trichomes.** The trichomes on the blades follow the types of those on the stems. Their shapes are quite the same on the upper and lower surfaces. Their number on the lower surface is generally greater than that on the upper surface, except in *Melothria japonica*, *Schizopepon bryoniifolius*, var. *japonicus*, *Momordica*



*Charantia*, *Trichosanthes japonica*, *T. multiloba* and *Gymnostemma cissoides*, in which the trichomes on the under-surface are borne only upon the veins. *Actinostemma racemosum* has them only upon the veins on both the upper and lower surfaces.

The following are the average numbers of the trichomes on the upper surface of the blades, omitting those species in which the trichomes grow only upon the veins :

<i>Lagenaria vulgaris</i>	36 per sq. mm.
<i>Cucurbita Pepo</i>	20 „
<i>Trichosanthes cucumeroides</i>	16 „
<i>Luffa cylindrica</i>	13 „
<i>Melothria japonica</i>	12 „
<i>Cucumis sativus</i>	12 „
<i>Benincasa cerifera</i>	12 „
<i>Cucumis Melo</i>	10 „
<i>Luffa acutangula</i>	9 „
<i>Trichosanthes japonica</i>	2 „
<i>T. multiloba</i>	2 „
<i>Schizopepon bryoniaefolius</i> , var.	
<i>japonicus</i>	2 „
<i>Citrullus vulgaris</i>	2 „
<i>Momordica Charantia</i>	18 in 5 sq. mm.
<i>Gymnostemma cissoides</i>	4 „

The average numbers of the trichomes on the under-surface are as follows, again omitting the species in which they are borne only upon the veins :

<i>Cucurbita Pepo</i>	80 per sq. mm.
<i>Lagenaria vulgaris</i>	52 „
<i>Trichosanthes cucumeroides</i>	52 „
<i>Benincasa cerifera</i>	28 „

<i>Cucumis Melo</i>	19 per sq. mm.
<i>Luffa cylindrica</i>	16 „
<i>L. acutangula</i>	10 „
<i>Cucumis sativus</i>	9 „
<i>Citrullus vulgaris</i>	4 „

Some of the trichomes are soft, while others are stiff, silicifying at the base centrifugally over the epidermal surface.<sup>1)</sup> The trichomes on the upper surface of the blade of *Melothria japonica*, and on both surfaces of the blades of *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus* and *C. Melo*, are good examples of the latter kind.

**Thickness of Blades.** The thickness of blades differs somewhat in each species. The average thickness of full-grown leaves is as follows :

<i>Luffa acutangula</i>	0.27 mm.
<i>L. cylindrica</i>	0.25 „
<i>Cucumis Melo</i>	0.21 „
<i>Benincasa cerifera</i>	0.20 „
<i>Cucumis sativus</i>	0.20 „
<i>Momordica Charantia</i>	0.18 „
<i>Citrullus vulgaris</i>	0.18 „
<i>Trichosanthes cucumeroides</i>	0.18 „
<i>T. japonica</i>	0.18 „
<i>T. multiloba</i>	0.17 „
<i>Lagenaria vulgaris</i>	0.16 „
<i>Gymnostemma cissoides</i>	0.16 „
<i>Actinostemma racemosum</i>	0.14 „

1) A. DE BARY. Comparative Anatomy of the Phanerogams and Ferns. Oxford 1884 p. 103.

<i>Melothria japonica</i>	0.14 mm.
<i>Cucurbita Pepo</i>	0.13 „
<i>Schizopepon bryoniaefolius</i> , var. <i>japonicus</i>	0.12 „

**Pallisade Parenchyma.** The thickness of the pallisade parenchyma is not uniform in all individuals. The results of microscopical measurements of it are given in the following table :

<i>Luffa acutangula</i>	0.120 mm.
<i>L. cylindrica</i>	0.095 „
<i>Cucurbita Pepo</i>	0.085 „
<i>Cucumis Melo</i>	0.075 „
<i>Benincasa cerifera</i>	0.070 „
<i>Cucumis sativus</i>	0.070 „
<i>Lagenaria vulgaris</i>	0.063 „
<i>Melothria japonica</i>	0.062 „
<i>Momordica Charantia</i>	0.062 „
<i>Citrullus vulgaris</i>	0.060 „
<i>Trichosanthes cucumeroides</i>	0.055 „
<i>Gymnostemma cissoides</i>	0.055 „
<i>Trichosanthes japonica</i>	0.052 „
<i>T. multiloba</i>	0.050 „
<i>Actinostemma racemosum</i>	0.050 „
<i>Schizopepon bryoniaefolius</i> , var. <i>japonicus</i>	0.050 „

The pallisade cells mostly occupy three- or four-tenths of the thickness of the blades, and sometimes even exceed six-tenths in *Cucurbita Pepo*, where the pallisade cells are at times arranged in double rows. The following will show these relations more clearly :

<i>Cucurbita Pepo</i>	0.085/0.13=0.65
<i>Luffa acutangula</i>	0.120/0.27=0.44
<i>Melothria japonica</i>	0.062/0.14=0.44
<i>Shizopepon bryoniaefolius</i> , var.	
<i>japonicus</i>	0.050/0.12=0.42
<i>Lagenaria vulgaris</i>	0.063/0.16=0.39
<i>Luffa cylindrica</i>	0.095/0.25=0.38
<i>Cucumis Melo</i>	0.075/0.21=0.36
<i>Actinostemma racemosum</i>	0.050/0.14=0.36
<i>Cucumis sativus</i>	0.070/0.20=0.35
<i>Benincasa cerifera</i>	0.070/0.20=0.35
<i>Momordica Charantia</i>	0.062/0.18=0.34
<i>Gymnostemma cissoides</i>	0.55/0.16=0.34
<i>Citrullus vulgaris</i>	0.60/0.18=0.33
<i>Trichosanthes cucumeroïdes</i>	0.55/0.18=0.31
<i>T. multiloba</i>	0.50/0.17=0.29
<i>T. japonica</i>	0.52/0.18=0.29

As to the breadth of the palisade cells some have a large diameter, as in *Actinostemma racemosum* and *Gymnostemma cissoides*, in which the breadth is nearly equal to the length (Pl. III. Fig. 41), while others have a comparatively small diameter, those of *Cucurbita Pepo*, *Luffa cylindrica*, and *L. acutangula* being remarkably long and narrow.

**Spongy Parenchyma.** The spongy parenchyma consists of 2-6-layered cells. The spongy cells of *Gymnostemma cissoides* are characterized by being only 2-3-layered and by being far larger than those of other species.

**Starch-grains.** The chloroplasts in the mesophyll of *Actino-*

*stemma racemosum* *Melothria japonica* and *Gymnostemma cissoides* contain large spindle-shaped starch-grains as a product of assimilation (Pl. III. Fig. 41).

**Mid-ribs.** The median line of the upper surface of the mid-ribs is always raised into a ridge, where the collenchyma is well-developed, and of the species of the Cucurbitaceæ under consideration, the one having the highest and sharpest ridge is *Gymnostemma cissoides*.

The fibro-vascular bundles of the mid-ribs near the proximal portion are arranged in six ways: the first type has a single bundle situated at the centre of the mid-rib (Pl. III. Fig. 43); the second has two bundles one above the other (Pl. III. Fig. 44); the third has three bundles, a larger one at the centre, the other smaller two on each side and above (Pl. III. Fig. 45); the fourth also has three bundles, but they are arranged in a straight line drawn from above downwards, the uppermost bundle being the smallest, while the lowest is the largest (Pl. III. Fig. 46); the fifth has four bundles, and is distinguished from the third type by having one more small bundle at the upper part of the central one (Pl. III. Fig. 47); the sixth has seven bundles, the largest bundle being undermost, and the other smaller six on each side and above (Pl. III. Fig. 48). *Actinostemma racemosum* and *Schizopepon bryoniaefolius*, var. *japonicus* belong to the first; *Melothria japonica*, to the second; *Gymnostemma cissoides*, to the third; *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, to the fourth; *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*, to the fifth; *Citrullus vulgaris* and *Cucurbita Pepo*, to the sixth.

In tracing the fibro-vascular bundles of the mid-ribs from base to apex we find that the first type retains the single bundle to the last; the second loses the smaller upper bundle on the way, and is reduced to a single bundle; the third is also reduced to one bundle near the apex, the associated bundles on each side being out of sight; the fourth loses the uppermost bundle first, then the middle one, the lowest bundle remaining to the end; in the fifth, the lateral bundles first disappear and then the uppermost bundle, the lowest one being the survivor; in the sixth the lateral bundles disappear from above downwards till the lowest bundle remains isolated.

*Collenchyma.* The position of the collenchyma developed in the mid-ribs varies somewhat according to the above six types: in the first, second, third, fourth, and fifth it is developed only at the upper and lower margins, but in the sixth, besides the preceding places, collenchyma is also developed on both sides of the mid-ribs.



## CHAPTER IV.

### THE PETIOLE.

*Contour.* The contour of the petioles, as seen in a transverse section, is not of a constant shape in the proximal, middle, and distal portions even in one and the same species. Generally



speaking, a transverse section cut through the distal portion shows a deep groove on the upper surface, while that of the proximal portion appears roundish, the groove becoming extremely shallow. The middle portion has an intermediate character. Besides, though many of the petioles are solid some of them have a large central hollow throughout, this being the case in *Benincasa cerifera*, *Cucurbita Pepo* (Pl. I. Fig. 15-17), and *Luffa acutangula*.

*Stomata.* Stomata are not found on the epidermis, where the collenchyma is developed; they are present only in the intercollenchymatous portions. The following are the average numbers of the stomata on the petioles of each species:

<i>Cucurbita Pepo</i>	12 per sq. mm.
<i>Trichosanthes multiloba</i>	12 „
<i>T. cucumeroides</i>	11 „
<i>Momordica Charantia</i>	11 „
<i>Actinostemma racemosum</i>	11 „
<i>Cucumis Melo</i>	11 „
<i>Citrullus vulgaris</i>	10 „
<i>Lagenaria vulgaris</i>	10 „
<i>Benincasa cerifera</i>	8 „
<i>Cucumis sativus</i>	8 „
<i>Trichosanthes japonica</i>	7 „
<i>Luffa cylindrica</i>	7 „
<i>L. acutangula</i>	7 „
<i>Gymnostemma cissoides</i>	6 „
<i>Melothria japonica</i>	4 „
<i>Schizopepon bryoniaefolius</i> , var.	
<i>japonicus</i>	3 „

**Trichomes.** The petioles may bear several kinds of trichomes or they may be nearly smooth. *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides* and *Cucurbita Pepo*, belong to the first group; *Actinostemma racemosum*, *Melothria japonica*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Trichosanthes japonica*, *T. multiloba* and *Gymnostemma cissoides*, to the second.

**Collenchyma.** In the middle portion of the petioles the collenchyma is developed outside of each fibro-vascular bundle. The number of the collenchyma groups varies from five to thirteen, the extremes being represented respectively by *Gymnostemma cissoides* and *Cucurbita Pepo*. In the distal as well as the proximal portions of the petioles several isolated collenchyma groups are united with one another, and in an extreme case all the groups of the collenchyma are entirely fused together.

**Sclerenchyma.** On the outside of each fibro-vascular bundle several-layered sclerenchymatous cells are formed, which are particularly well-developed in *Luffa cylindrica* and *L. acutangula*.

**Fibro-vascular Bundles.** The fibro-vascular bundles of the petioles have a circular arrangement. They are always in pairs laterally, while the undermost bundle is unpaired. Sometimes there appears a small bundle in the fundamental tissue under the groove. The undermost unpaired bundle is the largest of all and towards the upper portion of the petioles the paired bundles gradually decrease in size. The uppermost pair, when the upper surface of the petioles is deeply grooved, enters into

the ridges raised on both sides of the groove (Pl. I. Fig. 12-13). The number of the fibro-vascular bundles varies from five to thirteen. *Actinostemma racemosum*, *Melothria japonica* and *Gymnostemma cissoides* have five bundles; *Schizopepon bryoniaefolius*, var. *japonicus*, seven; *Momordica Charantia*,<sup>1)</sup> *Citrullus vulgaris*,<sup>2)</sup> *Cucumis sativus*, *C. Melo*,<sup>3)</sup> *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*, nine; *Luffa cylindrica*, *L. acutangula* and *Benincasa cerifera*, eleven; *Cucurbita Pepo*, thirteen.



## CHAPTER V.

### THE COTYLEDON.

The cotyledons are above the ground or underneath it. Those of *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*, are entirely buried in the soil. The anatomical structure of the cotyledons differs from that of the foliage-leaves.

**Epidermis.** When observed in a surface view the contour of the epidermal cells of the cotyledons is either straight or wavy as in the case of the foliage-leaves. On the upper surface

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1) H. A. LOTAR. *loc. cit.* p. 103.

2) Ditto. p. 95.

3) Ditto. p. 96.

of the cotyledons of *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, *Cucurbita Pepo*, and *Gymnostemma cissoides*, as well as on the under surface of those of *Momordica Charantia*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides*, the walls of the epidermal cells are straight; while they are wavy on the upper surface of those of *Actinostemma racemosum*, *Melothria japonica*, *Benincasa cerifera* and *Lagenaria vulgaris*, as well as on the under surface of those of *Actinostemma racemosum*, *Melothria japonica*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris* and *Cucurbita Pepo*.

**Stomata.** In nearly all of the species, as far as we have seen, stomata are found on both the upper and under surfaces of the cotyledons. Exceptions are however to be found in some species, where they are either almost exclusively on the upper side or only on the under. For example, in *Momordica Charantia*, *Trichosanthes japonica* and *T. multiloba*, they are chiefly on the upper, very rarely on the lower surface, while in *Gymnostemma cissoides* they are exclusively on the lower.

The numbers of the stomata found on the upper surface of the cotyledons of each species average as follows to a square millimetre :

<i>Citrullus vulgaris</i>	270
<i>Luffa cylindrica</i>	268
<i>L. acutangula</i>	260
<i>Cucurbita Pepo</i>	224
<i>Lagenaria vulgaris</i>	164

<i>Cucumis Melo</i>	142
<i>Benincasa cerifera</i>	125
<i>Actinostemma racemosum</i>	115
<i>Cucumis sativus</i>	93
<i>Melothria japonica</i>	43
<i>Momordica Charantia</i>	40
<i>Trichosanthes cucumeroides</i>	28
<i>T. japonica</i>	10
<i>T. multiloba</i>	4
<i>Gymnostemma cissoides</i>	0

Those on the under surface :

<i>Luffa cylindrica</i>	368 per sq. mm.
<i>L. acutangula</i>	360 „
<i>Cucumis Melo</i>	314 „
<i>C. sativus</i>	270 „
<i>Cucurbita Pepo</i>	253 „
<i>Citrullus vulgaris</i>	228 „
<i>Benincasa cerifera</i>	177 „
<i>Lagenaria vulgaris</i>	153 „
<i>Melothria japonica</i>	135 „
<i>Actinostemma racemosum</i>	118 „
<i>Gymnostemma cissoides</i>	15 „
<i>Trichosanthes cucumeroides</i>	11 „
<i>Momordica Charantia</i>	0† „
<i>Trichosanthes japonica</i>	0† „
<i>T. multiloba</i>	0† „

**Trichomes.** Some cotyledons are furnished with trichomes on both the upper and the lower surfaces ; others only on the

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† Stomata rarely occur.

upper, and yet others have none on either surface. Thus in *Luffa cylindrica*, *L. acutangula*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris* and *Cucurbita Pepo*, they are present on both surfaces; in *Melothria japonica* and *Citrullus vulgaris*, only on the upper; in *Actinostemma racemosum*, *Momordica Charantia*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides*, they are entirely absent.

**Pallisade Parenchyma.** The pallisade parenchyma of the cotyledons is generally many-layered; but there are some exceptional cases, in which the pallisade parenchyma can be scarcely recognised. The commonest type of the pallisade parenchyma consists of two or three-layered cells: e.g. *Actinostemma racemosum*, *Melothria japonica*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, and *Cucurbita Pepo*. In *Momordica Charantia*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides* the pallisade cells are indistinct.

**Spongy Parenchyma.** The layers of the spongy parenchyma-cells of the cotyledons are much more numerous than those of the foliage-leaves. A very peculiar structure of the spongy parenchyma appears in the cotyledons of *Actinostemma racemosum* where it presents a reticulate appearance, the cells radiating from a fibro-vascular bundle and thus leaving very large intercellular spaces among them, a character which reminds us of the inner structures of water-plants (Pl. IV. Fig. 49). The spongy parenchyma-cells of the cotyledons of *Momordica Charantia*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides*, are not well differentiated, and possess no marked intercellular spaces.



## CHAPTER VI.

## THE TENDRIL.

**Contour.** The contour of a transverse section through the proximal portion of a tendril is nearly circular. In the more remote portions it takes a more or less polygonal shape, and at the distal portion it becomes flattened. Especially in *Luffa acutangula* and *Benincasa cerifera* the surface of the main axis of the tendrils is elevated into noticeable longitudinal ridges. In *Benincasa cerifera* (Pl. IV. Fig. 50), *Cucurbata Pepo*, *Luffa acutangula* and *Schizopepon bryoniaefolius*, var. *japonicus* a central hollow is formed in the main axis of the tendrils.

**Stomata.** The average numbers of the stomata on the tendrils are not widely different in each species, as may be seen from the following table:

<i>Trichosanthes cucumeroides</i>	24 per sq. mm.
<i>T. japonica</i>	24 „
<i>T. multiloba</i>	24 „
<i>Gymnostemma cissoides</i>	24 „
<i>Actinostemma racemosum</i>	20 „
<i>Melothria japonica</i>	20 „
<i>Luffa cylindrica</i>	20 „
<i>L. acutangula</i>	20 „
<i>Benincasa cerifera</i>	20 „
<i>Momordica Charantia</i>	16 „
<i>Citrullus vulgaris</i>	16 „

<i>Cucumis sativus</i>	16 per sq. mm.
<i>C. Melo</i>	16 „
<i>Lagenaria vulgaris</i>	16 „
<i>Cucurbita Pepo</i>	16 „
<i>Schizopepon bryoniaefolius</i> , var.	
<i>japonicus</i>	16 „


**Collenchyma.** At the proximal portion of the tendrils we may distinguish three varieties of collenchyma according as it is developed: (i.) on all sides of the tendrils, (ii.) on the outside of each fibro-vascular bundle, and (iii.) outside of each fibro-vascular bundle as well as of each medullary ray. The first variety is found in *Melothria japonica*, *Cucumis sativus*, *C. Melo*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, *Gymnostemma cissoides*; the second, in *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris* and *Lagenaria vulgaris*; the third, in *Benincasa cerifera* and *Cucurbita Pepo*. In the distal portion, the collenchyma masses on the under side of the tendrils fuse into one another.

**Sclerenchyma.** At the proximal portion of the tendrils the sclerenchyma forms a continuous ring.<sup>1)</sup> At the distal portion, however, it is developed only on the ventral side of the tendrils.<sup>2)</sup> In *Benincasa cerifera* and *Lagenaria vulgaris* the sclerenchyma masses occur separately outside of each fibro-vascular bundle near the base of the tendrils, and those masses which are on the ventral side of the tendrils at the distal portion towards their apex, are united.

1) H. A. LOTAR. *loc. cit.* p. 139.

2) Ditto. p. 138.

**Fibro-vascular Bundles.** At the proximal portion of the tendrils the number of the fibro-vascular bundles varies from four to ten, gradually decreasing towards the distal portion. The maximum number of the bundles occurs in *Luffa cylindrica*, while the minimum is found in *Actinostemma racemosum* and *Gymnostemma cissoides*. *Luffa acutangula*, *Citrullus vulgaris*, *Benincasa cerifera*, *Momordica charantia*, *Cucurbita Pepo*, *Cucumis Melo*, *C. sativus*, *Lagenaria vulgaris*, *Trichosanthes multiloba*, *T. cucumeroides*, *T. japonica*, *Schizopepon bryoniaefolius*, var. *japonicus* and *Melothria japonica* have numbers intermediate between the extremes in a descending order.



## CHAPTER VII.

### THE ROOT.

Besides ordinary roots, tubers are met with in some species. They are, however, limited to one genus only, *Trichosanthes* which thus leads a perennial life, just as *Melothria japonica* and *Gymnostemma cissoides* preserve their vitality through the winter by means of rhizomes.

I shall now first take up the investigation of the anatomical structure of the ordinary roots, and then that of the tubers.

**Contour.** The contour of the root is not diversified like

that of the stem. It is mostly roundish, and in some cases it is more or less triangular or square, according to the number of fibro-vascular bundles present.

*Periderm.* Although the formation of periderm is common in old roots yet none have it so well-developed as that observed in the roots of *Trichosanthes cucumeroides*, *T. japonica*, and *T. multiloba*.

*Sclerenchyma.* When the roots are young, sclerenchyma is developed on the outside of each fibro-vascular bundle, but when they become old it breaks up into several parts, often forming two or three tangential parallel rows. When still further advanced in age numerous masses of sclerenchyma are found scattered in the cortex outside of each bundle as well as of each medullary ray. The degree of development of the sclerenchyma varies according to the species: some have well-developed and numerous sclerenchyma groups, while in others they are delicate and reduced. In *Melothria japonica*, *Trichosanthes cucumeroides*, and *Gymnostemma cissoides* the well-developed sclerenchyma forms a nearly continuous ring, but in *Schizopepon bryoniaefolius*, var. *japonicus*, *Benincasa cerifera*, and *Cucurbita Pepo* it is greatly reduced. At the angled portions of old roots of *Momordica Charantia* the sclerenchyma shows a characteristic double arrangement like that seen in the old stem, a mass of it being developed outside of each of the double fibro-vascular bundles heaped one upon the other.

*Fibro-vascular Bundles.* Most of the fibro-vascular bundles

in the main roots are tetrarch.<sup>1)</sup> In the lateral roots, however, di-, tri- or polyarch bundles are found especially in the adventitious roots: thus, for example, the pentarch occur in those of *Actinostemma racemosum*, *Melothria japonica*, *Luffa cylindrica*, *L. acutangula* and *Benincasa cerifera*; the hexarch, in those of *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, and *Gymnostemma cissoides*; the octarch, in those of *Cucurbita Pepo*.<sup>2)</sup> In old roots of *Momordica Charantia* the fibro-vascular bundles are arranged in double rows at the angled portions as in the old stem, one small secondary bundle, or occasionally two, being newly formed outside of the primary one.

(a) *Phloëm*. The sieve-tubes found in the roots are of smaller sizes than those of the stems. The diameters of the large sieve-tubes under consideration are shown in the following table:

<i>Lagenaria vulgaris</i>	0.075 mm.
<i>Benincasa cerifera</i>	0.070 „
<i>Momordica Charantia</i>	00.70 „
<i>Luffa cylindrica</i>	0.068 „
<i>L. acutangula</i>	0.067 „
<i>Cucurbita Pepo</i>	0.067 „
<i>Trichosanthes japonica</i>	0.060 „
<i>T. multiloba</i>	0.058 „
<i>Citrullus vulgaris</i>	0.057 „
<i>Trichosanthes cucumeroides</i>	0.055 „
<i>Cucumis sativus</i>	0.055 „
<i>C. Melo</i>	0.054 „
<i>Schizopepon bryoniæfolius</i> , var.	
<i>japonicus</i>	0.040 „

1) H. A. LOTAR. *loc. cit.* p. 155.

2) Ditto. p. 170.

<i>Actinostemma racemosum</i>	0.040 mm.
<i>Melothria japonica</i>	0.030 „
<i>Gymnostemma cissoides</i>	0.025 „

(b) *Xylem*. The xylem in the roots is well-developed and occupies the greater part of them. The sizes of the vessels in the roots are somewhat smaller than those of the stems.

	Diameter of the large vessel.
<i>Benincasa cerifera</i>	0.50 mm.
<i>Luffa cylindrica</i>	0.44 „
<i>L. acutangula</i>	0.43 „
<i>Lagenaria vulgaris</i>	0.43 „
<i>Cucurbita Pepo</i>	0.35 „
<i>Momordica Charantia</i>	0.33 „
<i>Citrullus vulgaris</i>	0.29 „
<i>Trichosanthes multiloba</i>	0.28 „
<i>T. cucumeroides</i>	0.25 „
<i>T. japonica</i>	0.24 „
<i>Cucumis Melo</i>	0.22 „
<i>C. sativus</i>	0.20 „
<i>Schizopepon bryoniifolius</i> , var.	
<i>japonicus</i>	0.17 „
<i>Actinostemma racemosum</i>	0.15 „
<i>Gymnostemma cissoides</i>	0.14 „
<i>Melothria japonica</i>	0.09 „

Thyloses<sup>1)</sup> within the vessels occur most commonly in old roots as they do in the old stems.

**Intercellular Spaces.** The intercellular spaces in the cortex of young roots are numerous and large. Those found in the roots of *Actinostemma racemosum* are exceptionally large, a trans-

1) H. A. LOTAR. *loc. cit.* p. 152.



verse section presenting an appearance like that of a water-plant (Pl. IV. Fig. 55). This peculiar character of the root of *Actinostemma racemosum* is not to be wondered at, when we consider that this plant always grows in the neighbourhood of a stream or in moist places, it having evidently acquired the character of a water-plant in order to adapt itself to its surroundings.

*Starch-grains and Crystals.* Reserve starch-grains of appreciable size are contained in old roots of the following species :

	Diameter of the large starch-grains.
<i>Gymnostemma cissoides</i>	0.023 mm.
<i>Trichosanthes multiloba</i>	0.020 „
<i>T. japonica</i>	0.020 „
<i>T. cucumeroides</i>	0.018 „
<i>Melothria japonica</i>	0.017 „
<i>Luffa cylindrica</i>	0.016 „
<i>L. acutangula</i>	0.014 „
<i>Actinostemma racemosum</i>	0.010 „
<i>Citrullus vulgaris</i>	0.009 „
<i>Cucurbita Pepo</i>	0.008 „

Crystals of calcium oxalate are met with in the old roots of *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Lagenaria vulgaris*, *Benincasa cerifera*, *Cucumis sativus*, *C. Melo*, &c., those of *Momordica Charantia* being the most remarkable in size and quantity.

*Tubers.* Tubers are found only in *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*. They occur in simple or grouped forms and attain an enormous size. A transverse section of a tuber shows a great degeneration of fibro-vascular bundles, the parenchyma itself being much increased so as to serve as a reserve tissue.

The periderm is well-developed and forms a thick layer around the tubers.

The sclerenchyma of the tubers is best developed in *Trichosanthos cucumeroides*, where it forms an almost continuous ring. In *Trichosanthos multiloba* the development of the sclerenchyma is somewhat checked and in *Trichosanthos japonica* it is very much retarded. The size of the sclerenchymatous cells and the thickness of their walls are much greater in the first two species than in the last. For the sake of a comparison I give the following numbers obtained from the measurements of the large sclerenchymatous cells in the tubers of the above three species :

	Diameter.	Thickness of the wall.
<i>Trichosanthos multiloba</i>	0.080 mm.	0.020 mm.
<i>T. cucumeroides</i>	0.050 „	0.020 „
<i>T. japonica</i>	0.030 „	0.008 „

The fibro-vascular bundles are most reduced in *Trichosanthos cucumeroides*, where many of the vessels are separated from each other. The following are the diameters of the large sieve-tubes in each species :

<i>Trichosanthos multiloba</i>	0.070 mm.
<i>T. japonica</i>	0.050 „
<i>T. cucumeroides</i>	0.045 „

Diameters of the large vessels :

<i>Trichosanthos multiloba</i>	0.42 mm.
<i>T. japonica</i>	0.35 „
<i>T. cucumeroides</i>	0.30 „

The starch-grains contained in the tubers attain their maximum size in *Trichosanthos multiloba*, those of *Trichosanthos japonica* coming next, and then those of *Trichosanthos cucumeroides*. In point of size the starch-grains from the tubers of *Trichosanthos multiloba*, however, stand second among those contained in the

various organs of the Cucurbitaceæ, the first place being held by those from the rhizome of *Gymnostemma cissoides*.<sup>1)</sup> The diameters of the large starch-grains from the tubers of *Trichosanthes* are as follows :

<i>Trichosanthes multiloba</i>	0.042 mm.
<i>T. japonica</i>	0.027 „
<i>T. cucumeroides</i>	0.018 „



## CHAPTER VIII.

### THE FRUIT.

The surface of the fruit of the Cucurbitaceæ is mostly smooth, except in *Actinostemma racemosum*, *Momordica Charantia* and *Cucumis sativus*, where it is raised into tubercles. The nature of the tubercles varies, for an examination of their anatomical structure shows that those of *Actinostemma racemosum* (Pl. IV. Fig. 58) and *Momordica Charantia* are only parenchymatous outgrowths, while those of *Cucumis sativus* are the large protuberant bases of trichomes, on which the latter have formerly rested (Pl. IV. Fig. 57).

**Epidermis.** The epidermal cells of the fruit have several distinct characters in the different species. To begin with, the shapes of the epidermal cells may be (a) radially flattened, (b)

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1) See p. 15.

cubical, or (c) radially elongated. To the first belong *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia* and *Gymnostemma cissoides*; to the second, *Melothria japonica*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*; to the third, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera* and *Cucurbita Pepo*, the epidermal cells of *Cucumis sativus* being the longest of all the radial diameter exceeding four times the tangential (Pl. V. Fig. 60); those of *Benincasa cerifera* are also characteristic, many of the cells having a tangential septum (Pl. V. Fig. 61).

A superficial view of the epidermal cells shows some variation in size, their diameters measuring 0.006–0.055 mm. *Actinostemma racemosum*, *Momordica Charantia*, *Gymnostemma cissoides* and *Citrullus vulgaris*, for example, being of the maximum size, while *Cucurbita Pepo* and *Cucumis sativus* are of the minimum size.

The walls of the epidermal cells of the fruit may be especially thick on the outer side or on the lateral sides, the outer half particularly manifesting an unusual thickening. *Melothria japonica*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Trichosanthes cucumeroides*, *T. japonica*, and *T. multiloba* belong to the latter; the remaining species to the former.

**Stomata.** The numbers of the stomata on the fruit may be shown by the following mean values in a square millimetre:

<i>Luffa cylindrica</i>	60
<i>L. acutangula</i>	50
<i>Cucurbita Pepo</i>	44
<i>Citrullus vulgaris</i>	37
<i>Cucumis Melo</i>	31

<i>C. sativus</i>	27
<i>Benincasa cerifera</i>	20
<i>Trichosanthes multiloba</i>	16
<i>Lagenaria vulgaris</i>	14
<i>Momordica Charantia</i>	12
<i>Actinostemma racemosum</i>	10
<i>Gymnostemma cissoides</i>	10
<i>Trichosanthes cucumeroides</i>	9
<i>T. japonica</i>	8
<i>Melothria japonica</i>	8
<i>Schizopepon bryoniaefolius</i> , var. <i>japonicus</i>	5

**Trichomes.** When young, the fruit bears several kinds of trichomes on its surface, but when they become old almost all of the trichomes have become detached from their bases, which then remain as traces of the once existing trichomes. We may distinguish four kinds of trichomes on the surface of the fruit: sharp-pointed conical hairs, blunt-ended conical hairs, short-stalked glandular hairs, and long-stalked glandular hairs, the details of which are quite the same as those of the stem.

**Cuticle.** The cuticle on the fruit-surface may be smooth or striated. In *Luffa cylindrica*, *L. acutangula*, *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Cucurbita Pepo*, *Momordica Charantia* and *Citrullus vulgaris* it is striated, that of *Luffa cylindrica* and *L. acutangula* being the most marked, the striations running out radially from the bases of the trichomes or from the stomata. In the remaining species it is smooth.

**Wax.** The fruit, when matured, has a greater or less deposit of wax on its surface. This wax covering is best developed on

the fruit of *Benincasa cerifera*, *Citrullus vulgaris* and *Cucurbita Pepo*. In *Benincasa cerifera* it consists of bundles of rods crossing one another like a trellis, and presenting a reticular appearance.<sup>1)</sup>

**Pericarp-tissue within the Epidermis.** The structure of the pericarp-tissue within the epidermis is not uniform in all species. Some fruits have a hardened ring in the outer tissue of the pericarp (Pl. V. Fig. 61), while in others this is lacking (Pl. V. Fig. 60). In *Actinostemma racemosum*, *Melothria japonica*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides* the hardened ring is developed, that of *Actinostemma racemosum* and *Melothria japonica* being incomplete and interrupted in many places (Pl. IV. Fig. 58); in *Schizopepon bryonicifolius*, var. *japonicus*, *Momordica Charantia*, *Cucumis sativus*, *C. Melo* and *Cucurbita Pepo* the mechanical sheath is entirely wanting.

The sclerenchymatous cells constituting the hardened ring may be thin-walled with numerous pits, as in *Actinostemma racemosum*, *Melothria japonica* and *Benincasa cerifera*, or may be thick-walled with distinct pore-canals, as in *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides*.

The hypodermal cells lying outside of the hardened ring are rather smaller than those of the deeper fundamental tissue, and when no hardened ring is present the parenchymatous cells of the outer part of the pericarp under the epidermis act as such. In *Lagenaria vulgaris* and *Benincasa cerifera* the hypodermal

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1) A DE BARY, *loc. cit.* p. 86.



cells are remarkably small, but in *Actinostemma racemosum* and *Momordica Charantia* they are exceptionally large.

The number of the layers of the hypodermal cells outside of the hardened ring should also be noticed. While usually they are many-layered in *Melothria japonica* and *Gymnostemma cissoides* they are reduced to the minimum; that is, in the former the hypodermal cells are one- or two-layered, but in the latter only one-layered.

**Fibro-vascular Bundles.** As a rule the fibro-vascular bundles in the fruit are weakly developed, and most of them have no sclerenchymatous sheath. Exceptions are found, however, in the fruit of *Luffa cylindrica* and *L. acutangula*. The fibres constituting the net-work of the *Luffa*-fruit are really the fibro-vascular bundles surrounded by the thick layers of the sclerenchymatous cells, which give a roundish shape to the fibres, and make them extremely elastic, the circumscribed bundles themselves remaining merely rudimentary (Pl. V. Fig. 59).

A peculiar arrangement of the fibro-vascular bundles is observed in the tubercles on the surface of the fruit of *Momordica Charantia*. A bundle enters into the tubercle perpendicular to the surface of the fruit, branching out near the top of the tubercle (Pl. IV. Fig. 56).

The sieve-tubes show a characteristic distribution in the fruit-tissue. Besides those found in the phloëm, there occur isolated sieve-tubes in the tissue of the pericarp within the epidermis (Pl. V. Fig. 61). In the species which have the hardened ring such as *Benincasa cerifera*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*, they occur in the hypoderma on the outside of the ring, and in *Schizopepon bryoniæfolius*, var. *japonicus*, *Cucumis*

*sativus*, *C. Melo* and *Cucurbita Pepo*, where the sclerenchymatous sheath is wanting, they are found in the outer part of the pericarp-tissue (Pl. V. Fig. 60).

**Parenchyma of the inner Part.** The parenchymatous cells which fill up the intervacular spaces are of enormous size, and the intercellular spaces among them are also remarkable. Especially, as we proceed to the inner part of the fruit do we find larger parenchymatous cells touching each other very slightly. In *Melothria japonica* the parenchymatous cells are transversely and tangentially elongated, and in *Momordica Charantia* they are transversely and radially elongated.

The structure of the innermost part of the fruit is often different from that of the other parts. In *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus* and *Gymnostemma cissoides* the innermost part of the fruit contains large intercellular spaces, which are most marked in *Actinostemma racemosum*, where the parenchyma presents a reticulate appearance.

**Starch-grains and Crystals.** Starch-grains are contained in the fruit of *Actinostemma racemosum*, *Melothria japonica*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*, *Cucurbita Pepo* and *Gymnostemma cissoides*, those of *Gymnostemma cissoides* being the largest (the major axis being 0.022 mm. long and the minor axis, 0.017 mm.), showing an irregular shape and a tubercular surface, while those of the other species are round and smooth. The quantity of the starch-grains in the fruit attains its maximum in *Melothria japonica* and *Gymnostemma cissoides*.

Crystals of calcium oxalate are found in the fruit of many species. Especially *Momordica Charantia* and *Benincasa cerifera* contain large quantities of them.



## CHAPTER IX.

### THE SEED.

**Contour.** - The contour of a transverse section through the seed shows interesting forms in each species (Pl. I. Fig. 18-33). In *Luffa cylindrica*, *L. acutangula*, *Cucumis sativus*, *C. Melo*, *Lagenaria vulgaris*, *Trichosanthes japonica*, *T. multiloba* and *Cucurbita Pepo* it is of a spindle shape; in *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus*, *Momordica Charantia*, *Trichosanthes cucumeroides* and *Gymnostemma cissoides* it is barrel-shaped, that of *Trichosanthes cucumeroides* having two processes on both truncated ends; and in *Melothria japonica*, *Citrullus vulgaris* and *Benincasa cerifera*, it is flattened, that of *Benincasa cerifera* being also noticeable for having three processes on both edges.

**Testa.** The testa of the Cucurbitaceæ consists, according to FICKEL,<sup>1)</sup> of the following seven layers: (i.) epidermis, (ii.) pitted

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1) J. F. FICKEL. *loc. cit.*

cells, mostly thick-walled, (iii.) stone-cells, (iv.) irregular thin-walled cells, which abound in intercellular spaces, (v.) thin-walled compressed cells, (vi.) the remnant of the nucellus, and (vii.) the remnant of the endosperm.

The epidermal cells constituting the first layer of the testa, when immersed in water, swell greatly. Their forms are very characteristic, being entirely different from the epidermal cells found in other parts of the plants. They are divided into three classes: (a) the flattened or cubical form, (b) the prismatic form, and (c) the prismatic form with thickened-ridges on the cell-wall. The first is found in *Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus* and *Gymnostemma cissoides*, and among these the lateral walls of the epidermal cells of the seed-coat of *Schizopepon bryoniaefolius*, var. *japonicus* deserve special notice, for they become thickened inwards, pointing gradually outwards. The second is found in *Momordica Charantia*,<sup>1)</sup> *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*; and the third, in *Melothria japonica*, *Luffa cylindrica*,<sup>2)</sup> *L. acutangula*, *Citrullus vulgaris*,<sup>3)</sup> *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris* and *Cucurbita Pepo*, and the thickened-ridges of *Cucurbita Pepo*,<sup>4)</sup> *Lagenaria vulgaris*<sup>5)</sup> and *Benincasa cerifera* ramify dendritically at the apex, while those of *Melothria japonica*, *Cucumis sativus*<sup>6)</sup> and *C. Melo*<sup>7)</sup> point towards the apex and extend towards the base (Pl. V. Fig. 64-65).

1) H. A. LOTAR. *loc. cit.* p. 221.

2) J. F. FICKEL. *loc. cit.* p. 771. and H. A. LOTAR. *loc. cit.* p. 218.

3) J. F. FICKEL. *loc. cit.* p. 757.

4) Ditto. p. 769. and H. A. LOTAR. *loc. cit.* p. 216.

5) J. F. FICKEL. *loc. cit.* p. 742.

6) C. D. HARZ. *loc. cit.* p. 777.

7) H. A. LOTAR. *loc. cit.* p. 216.

The cuticle on the epidermis is mostly thin, except in *Citrullus vulgaris*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*, where it is much thickened.

The thick-walled, irregular, pitted cells constituting the second layer of the testa have some intercellular spaces, and often attain a great thickness in, *Actinostemma racemosum*, *Schizopepon bryoniifolius*, var. *japonicus*, *Momordica Charantia*, *Citrullus vulgaris*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*.

In *Melothria japonica*, *Luffa cylindrica*, *L. acutangula*, *Cucumis sativus*, *C. Melo*, *Cucurbita Pepo* and *Gymnostemma cissoides* this layer occupies a comparatively small portion of the testa. That of *Cucurbita Pepo*<sup>1)</sup> and *Gymnostemma cissoides* is composed of thin-walled cells, furnished with reticulate thickenings. In some cases the second layer passes over gradationally to the third layer.

The stone-cells of the third layer of the testa are especially large, and polyhedral or roundish. They are characterized by the considerable thickness of their walls, and by the presence of a greatly reduced cavity as well as numerous branched pore-canals. This layer is made up of one or more rows of cells, which sometimes have small intercellular spaces. In *Luffa cylindrica*<sup>2)</sup> and *L. acutangula*<sup>3)</sup> it consists of rather large prismatic stone-cells (200  $\mu$  long and 37  $\mu$  wide), which are placed radially parallel; while in *Gymnostemma cissoides* it is made up of large reticulate cells.

The parenchymatous cells of the fourth layer are thin-walled

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1) H. A. LOTAR. *loc. cit.* p. 213.

2) Ditto. p. 221.

3) A. YASUDA. On the Anatomy of *Luffa acutangula* (L.) Roxb. Botanical Magazine, Tokyo. 1896. vol. x. No. 108. p. 37.

and pitted or reticulate. They are mostly irregular-shaped and often stellate, with many remarkable intercellular spaces. The reticulate cells occur in *Actinostemma racemosum* and *Cucurbita Pepo*,<sup>1)</sup> those of the former being especially large and noticeable (Pl. V. Fig. 63).

The tangentially compressed cells of the fifth layer are also thin-walled. They are gradually transferred over from the cells of the fourth layer.

The remnant of the nucellus coming under the fifth layer is a strongly refractive tissue, which is made up of the epidermis of the nucellus and several rows of compressed cells. Then follows the remnant of the endodermis, under which are laid the cotyledons (Pl. V. Fig. 62-66).



### SUMMARY.

1. The old stems of *Luffa cylindrica*, *L. acutangula*, *Momordica Charantia* and *Actinostemma racemosum* are very characteristic. They have a sharp keel along the angled portions. Microscopical examination shows that the ridges of *Luffa cylindrica* and *L. acutangula* consist only of outgrowths of the collenchyma, while those of *Momordica Charantia* and *Actinostemma racemosum* are formed by newly developed secondary fibro-vascular bundles.

2. Stomata on the stems of the Cucurbitaceæ may be

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1) J. F. FICKEL *loc. cit.* p. 757. and H. A. LOTAR. *loc. cit.* p. 214.



sometimes elevated with the epidermis above the surface of the latter, as if they were supported by short thick hairs.

3. Trichomes on the stems are of four kinds: (i.) sharp-pointed conical trichomes, (ii.) blunt-ended conical trichomes, (iii.) short-stalked glandular trichomes and (iv.) long-stalked glandular trichomes. The glandular trichome of *Trichosanthes cucumeroides* is especially characterized by having a single enlarged terminal cell; that of *Benincasa cerifera*, by having two processes at the apex; and that of *Cucurbita Pepo* by having the head consisting of two cells one overlying the other.

4. There are four types of the distribution of the sieve-tubes in the stems: (a) vascular-bundle sieve-tubes, (b) ectocyclic sieve-tubes, (c) entocyclic sieve-tubes, and (d) commissural sieve-tubes. *Luffa cylindrica* and *L. acutangula* have those of the first and third types; *Actinostemma racemosum*, *Melothria japonica*, *Schizopepon bryoniifolius*, var. *japonicus*, *Momordica Charantia*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides*, those of the first, third and fourth; and *Cucurbita Pepo*, all four types.

5. Rhizomes occur in *Melothria japonica* and *Gymnostemma cissoides*. They are long and thick, having at several nodes three scales, which are anatomically distinguished as a shoot, a leaf and a tendril. They are full of starch-grains, those of *Gymnostemma cissoides* being the largest (0.06 mm. in diameter) contained in any of the organs of the Cucurbitaceæ.

6. In the rhizomes the collenchyma, sclerenchyma and fibro-vascular bundles are considerably reduced. Their degeneration is much greater in *Melothria japonica* than in *Gymnostemma cissoides*.

7. The number of fibro-vascular bundles in the hypocotyls is generally six, except in *Citrullus vulgaris* and *Cucurbita Pepo*, the former of which has twelve, and the latter ten.

8. The epidermal cells on the upper surface of the blade of *Trichosanthes cucumeroides* are raised into conical papillæ pointing outwards.

9. The epidermis of the blades may be many-layered as in *Cucurbita Pepo*, a character which is limited to this species. *Momordica Charantia* contains globular cystoliths (0.065 mm. in diameter) in the greatly enlarged epidermal cells on the lower surface of the blade. They are united into groups.

10. Stomata on the upper surface of the blades are rarely found in *Momordica Charantia*, *Trichosanthes japonica* and *T. multiloba*, while they are entirely wanting in *Schizopepon bryoniaefolius*, var. *japonicus* and *Gymnostemma cissoides*.

11. The pallisade parenchyma is usually confined to three- or four-tenths of the thickness of the blades, but sometimes exceeds six-tenths in *Cucurbita Pepo*, where the pallisade cells may be arranged in double rows.

12. The fibro-vascular bundles of the mid-ribs near the proximal portion of the blades are arranged in six ways: the first type has a single bundle situated at the centre of the mid-ribs (*Actinostemma racemosum*, *Schizopepon bryoniaefolius*, var. *japonicus*); the second has two bundles overlapping each other (*Melothria japonica*); the third has three bundles, a larger one at the centre, the other smaller two on each side and above (*Gymnostemma cissoides*); the fourth also has three bundles, but they are arranged perpendicularly (*Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris*); the fifth has four bundles, and is distinguished from the third by having one more

small bundle on the upper part of the central one (*Momordica Charantia*, *Luffa cylindrica*, *L. acutangula*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba*); the sixth has seven bundles, the largest bundle undermost, the other six on each side and above (*Citrullus vulgaris*, *Cucurbita Pepo*).

13. The petioles are solid in general, except in *Cucurbita Pepo*, *Benincasa cerifera* and *Luffa acutangula*, in which they are hollow. The number of fibro-vascular bundles varies from five (*Actinostemma racemosum*, *Melothria japonica* and *Gymnostemma cissoides*) to thirteen (*Cucurbita Pepo*).

14. Stomata on the cotyledons are in many cases present on both the upper and lower surfaces. *Momordica Charantia*, *Trichosanthes japonica*, *T. multiloba* and *Gymnostemma cissoides* form an exception to this rule, the former three having the stomata on the lower surface, very rarely on the upper; while the last has them exclusively on the under side.

15. The pallisade parenchyma of the cotyledons is commonly several-layered, while the spongy parenchyma is many-layered. The mesophyll of the cotyledons of *Momordica Charantia*, *Trichosanthes cucumeroides*, *T. japonica*, *T. multiloba* and *Gymnostemma cissoides* is, however, scarcely differentiated into the pallisade and spongy tissues.

16. The spongy parenchyma of the cotyledons of *Actinostemma racemosum* shows a reticulate appearance, the cells radiating from a fibro-vascular bundle and thus leaving very large intercellular spaces, so that it reminds one of the leaf-tissue of water-plants.

17. Unlike the common solid types, the stems of *Cucurbita Pepo*, *Benincasa cerifera*, *Lagenaria vulgaris*, the hypocotyls of *Cucurbita Pepo*, *Benincasa cerifera*, *Lagenaria vulgaris*, *Cucumis*

*Melo*, and the main axis of the tendrils of *Cucurbita Pepo*, *Benincasa cerifera*, *Luffa acutangula*, *Schizopepon bryoniaefolius*, var. *japonicus* are equally furnished with a central hollow.

18. The number of stomata found on the tendrils is nearly the same in all species. The number of fibro-vascular bundles varies from four (*Actinostemma racemosum*, *Gynenostemma cissoides*) to ten (*Luffa cylindrica*).

19. In the old roots of *Momordica Charantia* the fibro-vascular bundles have a double arrangement at the angled portions, as in the old stems.

20. The young roots of *Actinostemma racemosum* have remarkably wide intercellular spaces, the cause of which is to be found in the habitus of the plant.

21. Tubers are confined to *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*. The largest starch-grains contained in the roots are those of the tuber of *Trichosanthes multiloba* (0.042 mm. in diameter).

22. The epidermal cells of the fruit may be radially flattened, cubical, or radially elongated. *Cucumis sativus* is characterized by having the epidermal cells four times longer radially than tangentially; and *Benincasa cerifera*, by having a tangential septum in many of them.

23. In the pericarp-tissue a sclerenchymatous ring, either complete or incomplete, is generally formed. In *Schizopepon bryoniaefolius*, var. *japonicus*, *Cucumis sativus*, *C. Melo* and *Cucurbita Pepo*, however, it is entirely absent.

24. The surface of the fruit of *Actinostemma racemosum*, *Momordica Charantia* and *Cucumis sativus* is raised into tubercles. The origin of the tubercles varies; for those of *Actinostemma racemosum* and *Momordica Charantia* are anatomically proved to be

parenchymatous outgrowths, while those of *Cucumis sativus* are the large protuberant bases of trichomes, which have become detached.

25. Sieve-tubes have a characteristic distribution in the fruits. Besides those found in the phloëm there are isolated sieve-tubes in the tissue of the pericarp. These extra-phloëm sieve-tubes occur in the hypoderma outside of the hardened ring. And when no hardened ring is present they are found in the outer part of the pericarp-tissue.

26. Into the tubercles on the surface of the fruit of *Momordica Charantia* a fibro-vascular bundle enters, and runs perpendicularly to the surface branching out near the top of the tubercle. Nothing of this kind is observed in other genera.

27. The anatomical structure of the fibro-vascular bundles in the fruit of *Luffa cylindrica* and *L. acutangula* deserves notice because of the fact that the well-developed sclerenchyma surrounds the remaining weakly-developed portion of the bundle, the whole forming a spongy mass.

28. We may distinguish three kinds of epidermal cells in the seeds: a) flattened or cubical cells, b) prismatic cells, and c) prismatic cells with thickened-ridges on their walls. To the first class belong *Actinostemma racemosum*, *Schizopepon bryoniifolius*, var. *japonicus* and *Gymnostemma cissoides*; to the second, *Momordica Charantia*, *Trichosanthes cucumeroides*, *T. japonica* and *T. multiloba*; and to the third, *Melothria japonica*, *Luffa cylindrica*, *L. acutangula*, *Citrullus vulgaris*, *Cucumis sativus*, *C. Melo*, *Benincasa cerifera*, *Lagenaria vulgaris* and *Cucurbita Pepo*. The thickened-ridges of *Benincasa cerifera*, *Lagenaria vulgaris* and *Cucurbita Pepo* ramify dendritically at the apex, while those of *Melothria japonica*, *Cucumis sativus*, *C. Melo* are pointed towards the apex and widen towards the base.

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ON THE COMPARATIVE ANATOMY OF THE CUCURBITACEÆ, WILD AND CULTIVATED,  
IN JAPAN,

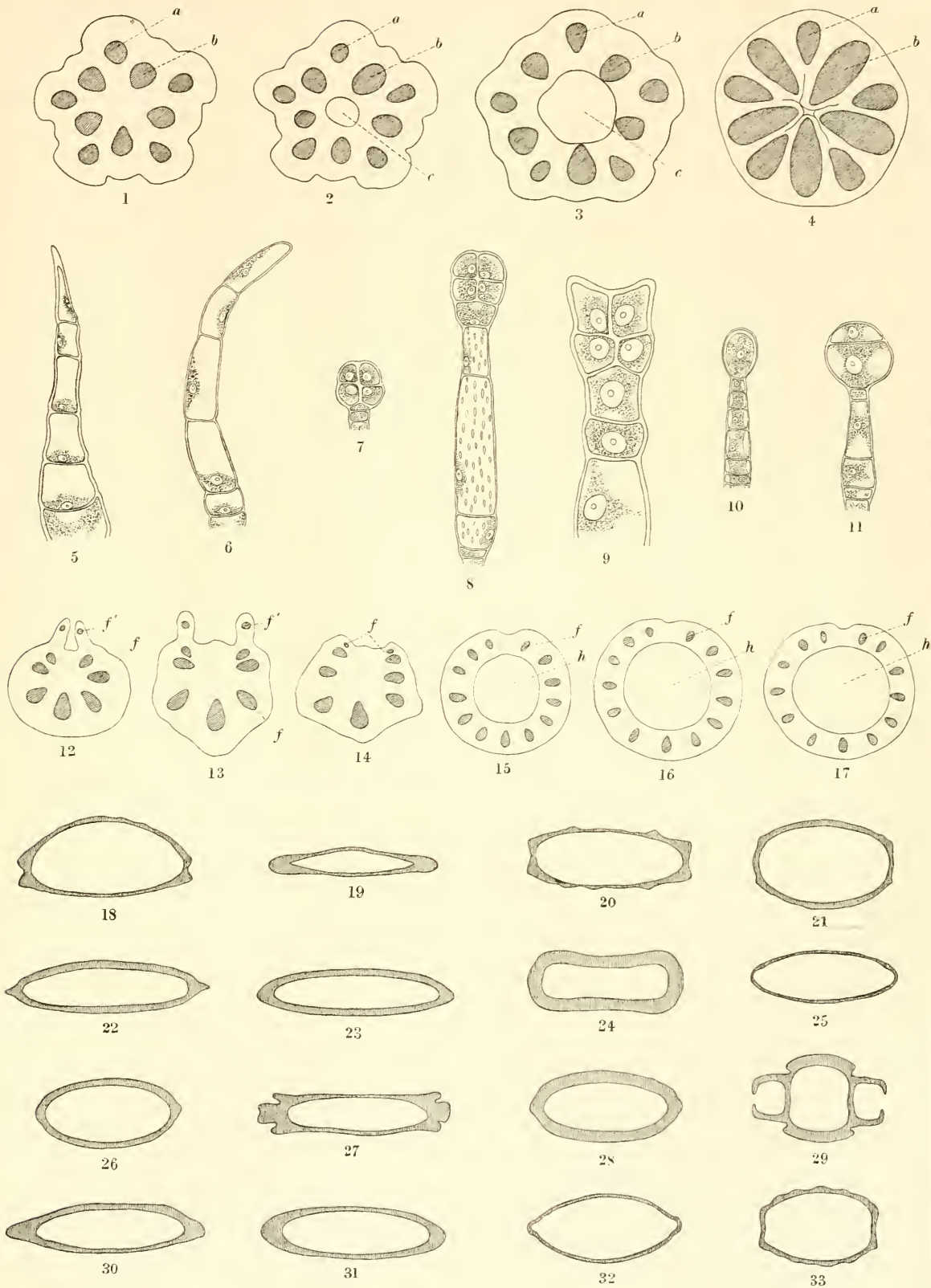
PLATE I.

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Plate I.

- Fig. 1-4. Diagrammatic representation of transverse sections through the stem of *Benincasa cerifera* in various stages. Fig. 1. A young stem; Fig. 2. A growing stem; Fig. 3. A full-grown stem; Fig. 4. An old stem. *a*, fibro-vascular bundle of the outer ring; *b*, fibro-vascular bundle of the inner ring; *c*, central hollow.
- Fig. 5. Sharp-pointed conical trichome of *Melothria japonica*. Zeiss,  $2 \times D$ .

- Fig. 6. Blunt-ended conical trichome of *Schizopepon bryoniifolius*, var. *japonicus*. Zeiss,  $2 \times D$ .
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- Fig. 8. Long-stalked glandular trichome of *Cucumis sativus*. Zeiss,  $2 \times D$ .
- Fig. 9. The same of *Benincasa cerifera*. Zeiss,  $2 \times D$ .
- Fig. 10. " " " *Trichosanthes cucumeroides*. Zeiss,  $2 \times D$ .
- Fig. 11. " " " *Cucurbita Pepo*. Zeiss,  $2 \times D$ .
- Fig. 12-14. Diagrammatic representation of transverse sections through various portions of the petiole of *Momordica Charantia*. Fig. 12. The distal portion; Fig. 13. The middle portion; Fig. 14. The proximal portion. *f'*, fibro-vascular bundle; *f*, fibro-vascular bundle entering the ridges, which are raised on both sides of the groove.
- Fig. 15-17. Diagrammatic representation of transverse sections through various portions of a petiole of *Cucurbita Pepo*. Fig. 15. The distal portion; Fig. 16. The middle portion; Fig. 17. The proximal portion. *f*, fibro-vascular bundle; *h*, central hollow.
- Fig. 18. Scheme of the median transverse section through the testa of *Actinostemma racemosum*.
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- Fig. 20. " " " *Schizopepon bryoniifolius*, var. *japonicus*.
- Fig. 21. " " " *Momordica Charantia*.
- Fig. 22. " " " *Luffa cylindrica*.
- Fig. 23. " " " *L. acutangula*.
- Fig. 24. " " " *Citrullus vulgaris*.
- Fig. 25. " " " *Cucumis sativus*.
- Fig. 26. " " " *C. Melo*.
- Fig. 27. " " " *Benincasa cerifera*.
- Fig. 28. " " " *Lagenaria vulgaris*.
- Fig. 29. " " " *Trichosanthes cucumeroides*.
- Fig. 30. " " " *T. japonica*.
- Fig. 31. " " " *T. multiloba*.
- Fig. 32. " " " *Cucurbita Pepo*.
- Fig. 33. " " " *Gymnostemma cissoides*,





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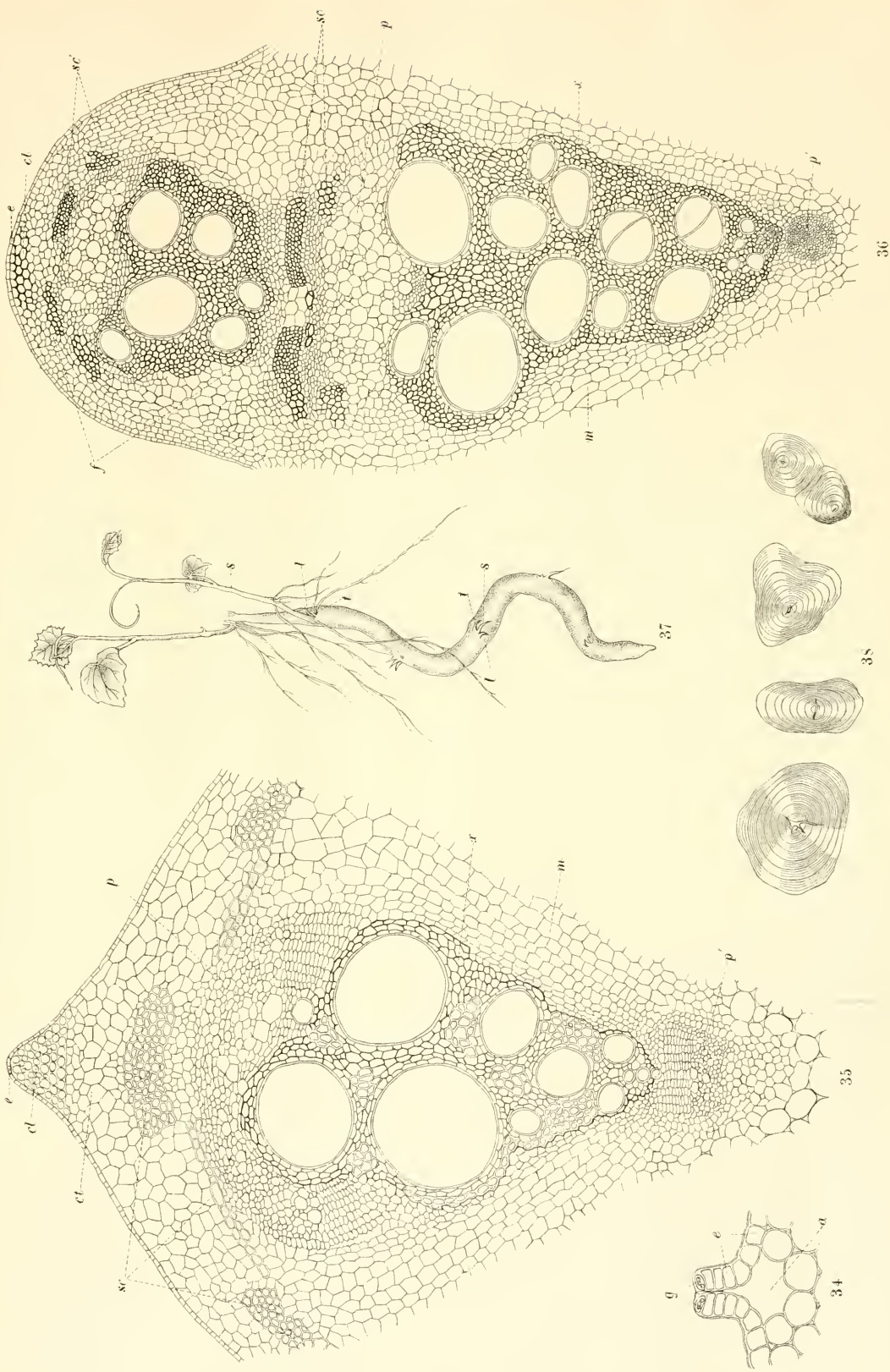
ON THE COMPARATIVE ANATOMY OF THE CUCURBITACEÆ, WILD AND CULTIVATED,  
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PLATE II.

## Plate II.

- Fig. 34. Elevated stoma from the stem of *Lagenaria vulgaris*. *g*, guard-cells; *e*, epidermal cells; *a*, respiratory cavity. Zeiss,  $4\times$  D.
- Fig. 35. Transverse section through an angled portion of an old stem of *Luffa cylindrica*, showing the sharp ridge consisting of collenchyma. *e*, epidermis; *cl*, collenchyma; *ct*, cortex; *sc*, sclerenchyma; *p*, peripheral phloëm; *p'*, axial phloëm; *x*, xylem; *m*, medullary ray. Zeiss,  $2\times$  B.
- Fig. 36. Transverse section through a keeled portion of an old stem of *Momordica Charantia*, showing the sharp ridge consisting of a newly formed secondary fibro-vascular bundle. *e*, epidermis; *cl*, collenchyma; *f*, newly formed secondary fibro-vascular bundle; *p*, peripheral phloëm; *p'*, axial phloëm; *x*, xylem of the primary bundle; *sc*, sclerenchyma of the primary bundle; *sc'*, sclerenchyma of the secondary bundle; *m*, medullary ray. Zeiss,  $1\times$  B.
- Fig. 37. Rhizome of *Melothria japonica* gathered in May. At each node three scales are developed, which are destined respectively to be a shoot (*s*), a leaf (*l*), and a tendril (*t*). Natural size.
- Fig. 38. Starch-grains from the rhizome of *Gymnostemma cissoïdes*. Zeiss,  $4\times$  D.







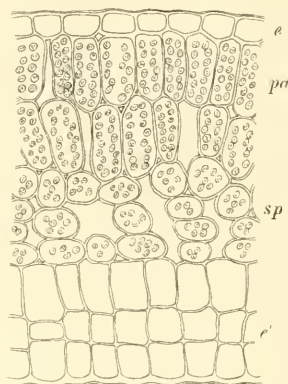
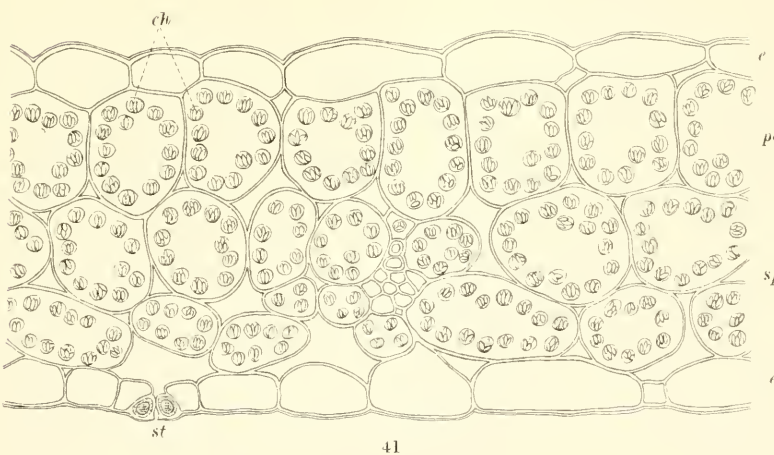
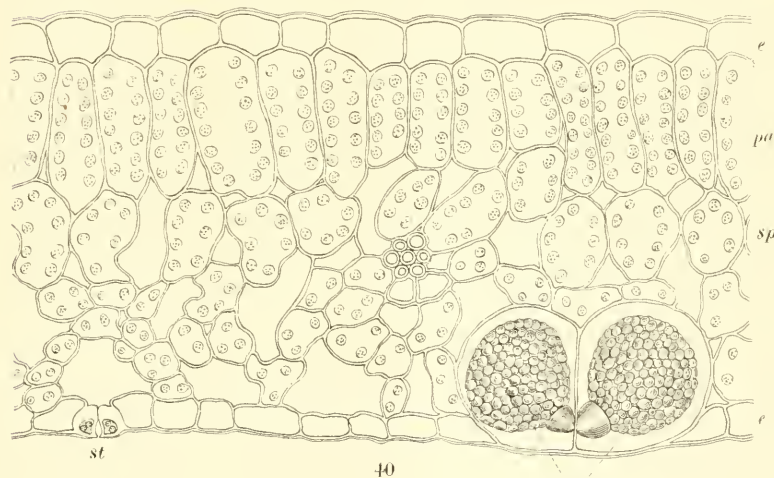
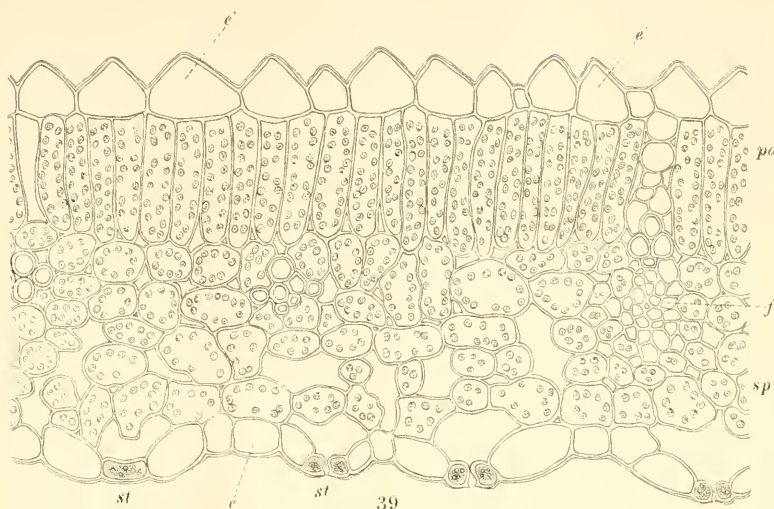
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PLATE III.

### Plate III.

- Fig. 39. Transverse section of the blade of *Trichosanthes cucumeroides*. *c*, epidermal cell on the under surface raised into conical papillae outwards; *st*, stoma; *pa*, pallisade parenchyma; *sp*, spongy parenchyma; *f*, fibro-vascular bundle. Zeiss,  $4\times$  D.
- Fig. 40. Transverse section of the blade of *Momordica Charantia*. *c*, cystoliths; *e*, epidermis; *st*, stoma; *pa*, pallisade parenchyma; *sp*, spongy parenchyma. Zeiss,  $4\times$  D.
- Fig. 41. Transverse section of the blade of *Gymnostemma cissoides*. *ch*, chloroplasts containing large spindle shaped starch-grains; *e*, epidermis; *st*, stoma; *pa*, pallisade parenchyma; *sp*, spongy parenchyma. Zeiss,  $4\times$  D.
- Fig. 42. Transverse section of the blade of *Cucurbita Pepo* through the etiolated portion. *e*, epidermis; *e'*, many-layered epidermis; *pa*, pallisade parenchyma; *sp*, spongy parenchyma. Zeiss,  $4\times$  D.
- Fig. 43-48. Diagrammatic representation of six types of the mid-ribs of the leaves in reference to the manner of development of fibro-vascular bundles. Cross sections. Fig. 43. *Actinostemma racemosum*; Fig. 44. *Melothria japonica*; Fig. 45. *Gymnostemma cissoides*; Fig. 46. *Cucumis salicis*; Fig. 47. *Momordica Charantia*; Fig. 48. *Cucurbita Pepo*. *f*, fibro-vascular bundle.







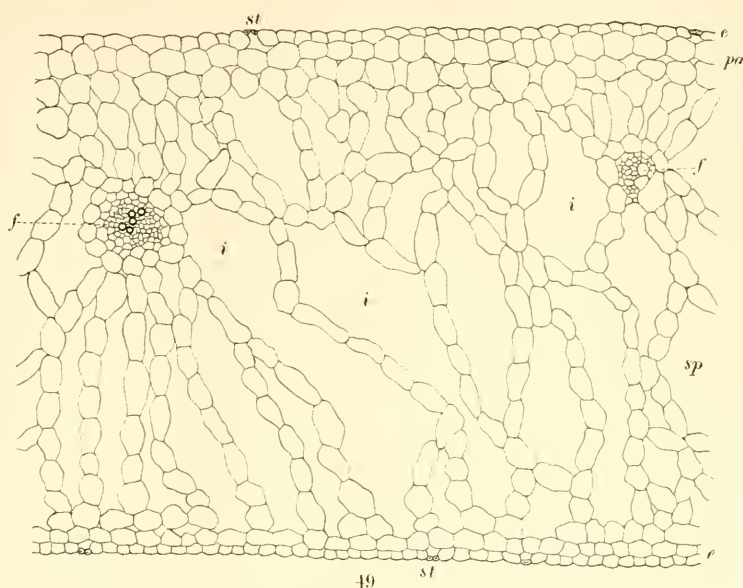
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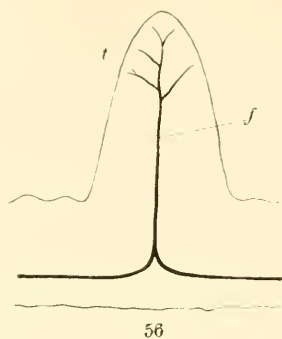
PLATE IV.

## Plate IV.

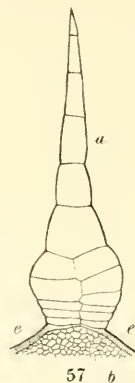
- Fig. 49. Transverse section of a cotyledon of *Actinostemma racemosum*. *e*, epidermis; *st*, stoma; *pa*, pallisade-parenchyma; *sp*, spongy parenchyma; *f*, fibro-vascular bundle; *i*, intercellular space. Zeiss,  $2 \times B$ .
- Fig. 50-54. Diagrams of transverse sections of a tendril of *Benincasa cerifera* through various portions. Fig. 50. The proximal portion; Fig. 51. A farther portion; Fig. 52 and Fig. 53. Still farther portions; Fig. 54. The distal portion. *f*, fibro-vascular bundle; *h*, central hollow.
- Fig. 55. Transverse section of a young root of *Actinostemma racemosum*. *e*, epidermis; *i*, intercellular space; *en*, endodermis; *pc*, pericambium; *x*, tetrarch bundle. Zeiss,  $4 \times B$ .
- Fig. 56. Scheme of a longitudinal section through a tubercle on the surface of the fruit of *Momordica Charantia*. *f*, fibro-vascular bundle; *t*, tubercle.
- Fig. 57. Trichome from the surface of a young fruit of *Cucumis sativus*, supported on a protuberant parenchymatous base. *a*, trichome; *e*, epidermis; *b*, protuberant parenchymatous base. Zeiss,  $2 \times B$ .
- Fig. 58. Longitudinal section through a tubercle on the surface of the fruit of *Actinostemma racemosum*. *t*, tubercle composed of parenchyma; *e*, epidermis; *p*, parenchyma; *sc*, a portion of sclerenchyma forming an incomplete ring around the pericarp; *f*, reduced fibro-vascular bundle. Zeiss,  $3 \times B$ .



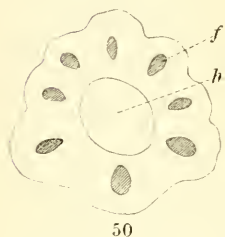
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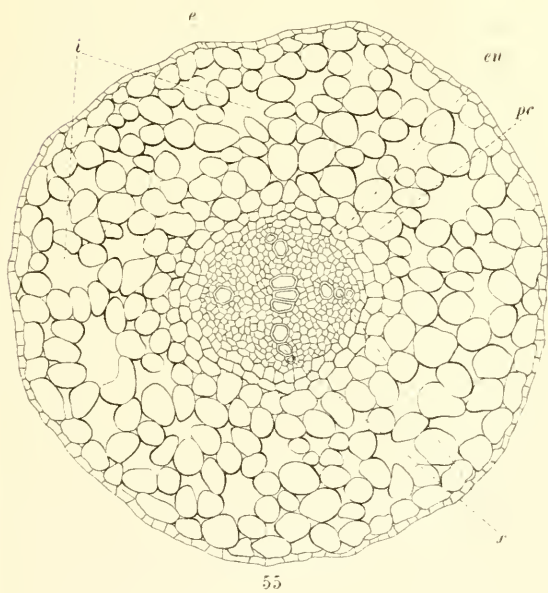
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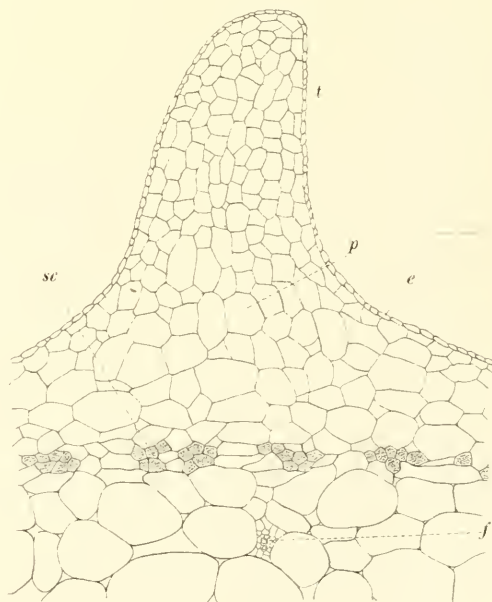
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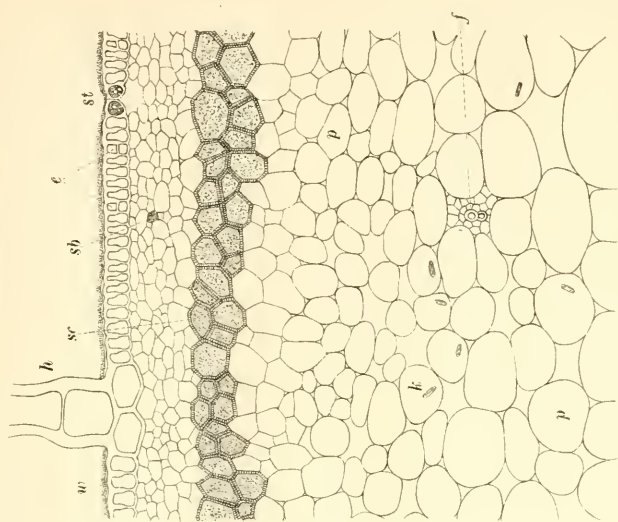
ON THE COMPARATIVE ANATOMY OF THE CUCURBITACEÆ, WILD AND CULTIVATED,  
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PLATE V.

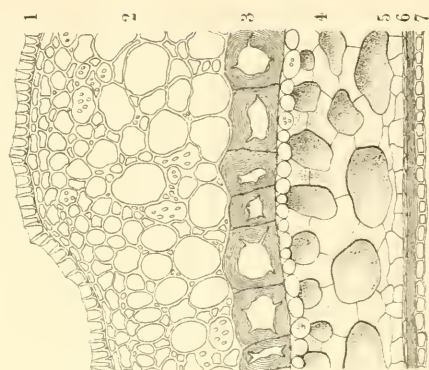
## Plate V.

- Fig. 59. Transverse section of a fibro-vascular bundle in the fruit-tissue of *Luffa cylindrica*. *sc*, well-developed sclerenchymatous sheath; *f*, enclosed rudimentary bundle; *p*, parenchymatous cell. Zeiss,  $4\times B$ .
- Fig. 60. Transverse section through the pericarp of *Cucumis sativus*. *e*, prismatic epidermal cell; *st*, stoma; *sb*, extra-phloëm sieve-tube; *p*, parenchymatous cell. Zeiss,  $4\times B$ .
- Fig. 61. Transverse section through the pericarp of *Benincasa cerifera*. *w*, wax; *e*, epidermal cell having a tangential septum; *h*, trichome; *st*, stoma; *sb*, extra-phloëm sieve-tube; *sc*, sclerenchymatous ring; *p*, parenchyma; *f*, fibro-vascular bundle; *k*, crystal. Zeiss,  $4\times B$ .
- Fig. 62. Transverse section through the testa of *Luffa acutangula*. 1, first layer: prismatic epidermal cells with thickened-ridges; 2, second layer: small thick-walled pitted cells; 3, third layer: one row of characteristic large prismatic stone-cells; 4, fourth layer: thin-walled stellate pitted cells; 5, fifth layer: thin-walled compressed cells; 6, sixth layer: the remnant of the nucellus; 7, seventh layer: the remnant of the endosperm. *r*, thickening-ridge. Zeiss,  $2\times D$ .
- Fig. 63. Transverse section through the testa of *Actinostemma racemosum*. 1, first layer: flattened epidermal cells; 2, second layer: thick-walled reticulate and pitted cells; 3, third layer: several-layered stone-cells; 4, fourth layer: remarkably large reticulate cells; 5, 6, and 7, fifth, sixth, and seventh layers, like those in fig. 62.
- Fig. 64. Transverse section through the testa of *Melothria japonica*. 1, first layer: prismatic epidermal cells with pointed, thickened-ridges; 2, second layer: thick-walled pitted cells; 3, third layer: stone-cells; 4, fourth layer: slightly pitted thin-walled cells; 5, 6, and 7, fifth, sixth, and seventh layers, like those in fig. 63. *r*, thickened-ridge. Zeiss,  $2\times D$ .
- Fig. 65. Tangential section through the epidermis of the testa of *Melothria japonica*. *e*, epidermal cell; *r*, thickened-ridges. Zeiss,  $2\times D$ .
- Fig. 66. Transverse section through the testa of *Schizopepon bryoniæfolius*, var. *japonicus*. 1, first layer: cubical epidermal cells with the thickened lateral walls; 2, second layer: thick-walled pitted cells; 3, third layer: large stone-cells; 4, fourth layer: stellate thin-walled pitted cells; 5, 6, and 7, fifth, sixth, and seventh layers, like those in fig. 64. Zeiss,  $2\times D$ .

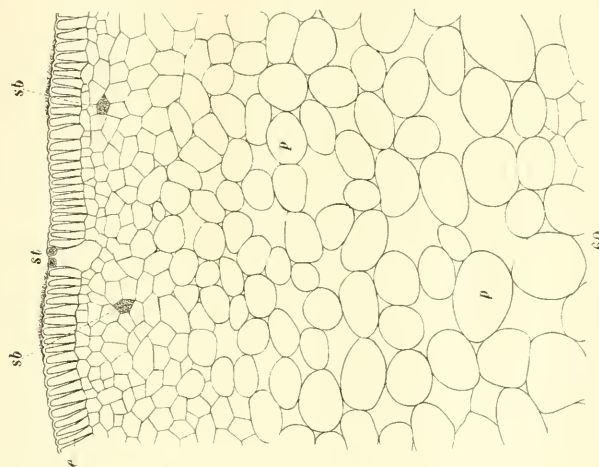




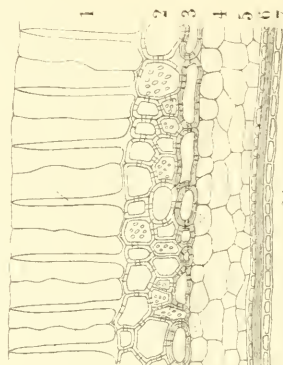
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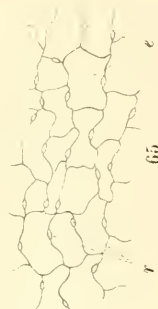
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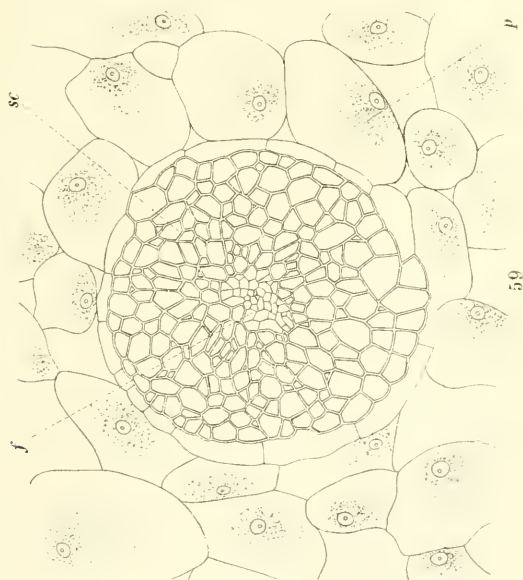
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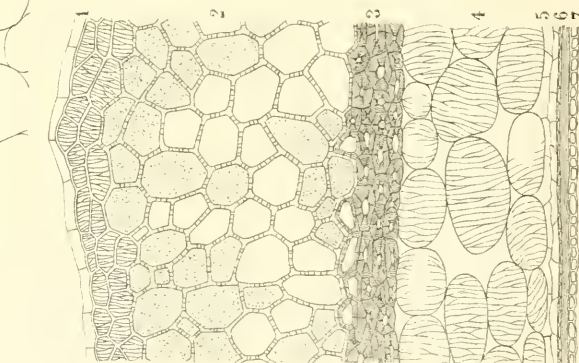
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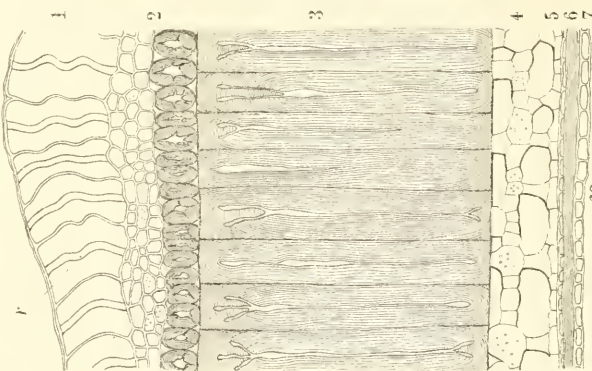
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## Untersuchungen über die atmosphärischen Pilzkeime.

(I. Mittheilung.)

von

**K. Saito**, *Rigakushi*.

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mit *Tafeln I.-V.*

---

### I. Einleitung.

Von Herrn Professor Dr. MIYOSHI war ich während des verflossenen Jahres mit einer Arbeit betraut, deren Resultate ich in vorliegender Abhandlung niedergelegt habe. Das Thema der Arbeit war eine möglichst vollständige Erforschung der Schimmelpilz-, Bakterien- und Hefenkeime der Luft an verschiedenen Örtlichkeiten Tokios, oder, in anderen Worten: Untersuchungen über die Luftkeime der Stadt Tokio sowohl in quantitativer als auch in qualitativer Hinsicht. Bevor ich auf die Beschreibung der Versuche eingehe, sei es mir erlaubt, kurz über die einschlägige Litteratur zu berichten.

Seit den bahnbrechenden Forschungen PASTEURS weiss man, dass die mikrobiologische Zusammensetzung der Luft in hygienischer und gährungstechnischer Beziehung von einer grossen Bedeutung ist; deshalb sind diesbezügliche Untersuchungen vielfach

unternommen worden. Von den vielen Luftanalysen, die von verschiedenen Seiten ausgeführt wurden, sind diejenigen von MIQUEL, welche in der Station zu Montsouris bei Paris viele Jahre hindurch vom mikrobiologischen Standpunkte aus durchgeführt wurden, in erster Linie zu nennen. In seiner, im Jahre 1883 erschienenen klassischen Arbeit<sup>1)</sup> legte MIQUEL auf Grund vieljähriger Untersuchungen fest, dass sowohl die Zahl als auch die Arten der in der Luft suspendierten kleinen Körperchen (Mineralien, Pollenkörner, Algen, Pilze, Bakterien u. s. w.) nach den Jahreszeiten variieren, so dass z. B. die Keimzahl der Schimmelpilze in warmen und feuchten Jahreszeiten am grössten, in kalten und trockenen hingegen am geringsten ist.

Auch die Arbeit von HANSEN<sup>2)</sup> zeigte, dass die Keimzahl und der Artencharakter der Mikroorganismen der Luft je nach dem Ort und der Zeit verschieden und von manichfachen obwaltenden Faktoren abhängig sind. Nach ihm waren die Schimmelpilze stets am häufigsten zu treffen, danach kamen in der Reihenfolge Bakterien und schliesslich Hefen.

Zu erwähnen ist noch, dass die Luft am Meere nach FISCHER<sup>3)</sup>, MOREU und MIQUEL<sup>4)</sup> und MINERVINI<sup>5)</sup> einen relativ geringeren Keimgehalt aufwies; gleiches gilt auch für höhere Luftschichten der Berge, wo nach GIACOSA<sup>6)</sup> die entwicklungsfähigen Keime

1) Les organismes vivant de l'atmosphère. 1883.

2) Recherches sur les organismes qui, a différentes époques de l'année, se trouvent dans l'air a Carlsberg et aux alentours, etc. (Ref. im Bot. Centralbl. 1882. III. p. 7.)

3) FISCHER, B., Bakteriologische Untersuchungen auf einer Reise nach Westindien. Zeitschrift f. Hygiene, 1886, p. 421.

4) MOREU und MIQUEL, Gehalt der Seeluft an Mikroorganismen. Chem. Centralbl., 1886, No. 26.

5) MINERVINI, R., Einige bakteriologische Untersuchungen über Luft und Wasser inmitten des Nord-Atlantischen Oceans. (Zeitschr. für Hygiene und Infektionskr., XXXV, p. 166.)

6) GIACOSA, P., Sopra i germi centenuti ell'aria a grandi altezze. (Ref. in *JUST*, Bot. Jahresb., 1883, Bd. I, p. 308.)

der Schizomyceten mit der Höhe an Zahl abnehmen, während die Schimmelpilze dabei noch recht zahlreich zum Vorschein kommen.

Was die Luft in Städten, Schulen und Hospitälern anbelangt, so berichtet MIQUEL<sup>1)</sup> dass die Luft in den Städten weniger rein ist als die der Umgebung, und dieselbe im Hospitale vielmal reicher an Bakterien ist als die im Garten. MIFLET<sup>2)</sup> untersuchte hauptsächlich die Bakterienkeime in der Luft von Kloakenräumen und Arbeitszimmern seines Instituts, in dem Operationszimmer der chirurgischen Klinik, dem Sektionszimmer des pathologischen Instituts u. s. w. und fand an diesen Orten verschiedene Arten der Bakterien; Schimmelpilze jedoch erwähnt er nur nebensächlich. SELANDER<sup>3)</sup> erhielt aus der Luft der Festung Vaxholm 192 Schimmelpilzkolonien, wounter 95% zu *Penicillium glaucum* gehörten und die übrigen *Botrytis cinerea*, *Oidium lactis* und eine andere nicht bestimmte Art waren. Gleichartige Untersuchungen wurden neuerdings von CACACE<sup>4)</sup> in der Schule zu Capua gemacht, und verschiedene Mikroben und Schimmelpilze aufgefunden.

In den obenerwähnten Arbeiten findet man eine ausführliche statistische Untersuchung über die Schimmelpilzkeime in der Luft nicht; zwar erwähnt HANSEN<sup>5)</sup> das häufige Vorkommen von *Cladosporium herbarum*, *Dematium pullans*, danach *Botrytis*, *Mucor* und *Oidium*. Da aber die Zahl und Art der Luftkeime, hier

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1) MIQUEL, l. c.

2) MIFLET, Untersuchungen über die in der Luft suspendierten Bakterien. COHN's Beiträge, Bd III, p. 119.

3) SELANDER, N. E., Luftuntersuchungen bei der Festung Vaxholm. Sv. vet. Ak. Bih. Bd. 13, 1886. No. 9. (Just's Bot. Jahresb., 1886, Bd XVI, I, p. 230.)

4) CACACE, E., Die Bakterien der Schule. Bakteriologische Untersuchungen ausgeführt an dem Staube der Normalschule zu Capua. (Centralbl. f. Bakteriologie, I Abtheilung, Bd. XXX, 1901, p. 653-657.)

5) Citirt in JÖRGENSEN, Mikroorganismen in der Gährungsindustrie. Vierte Auflage. p. 50.



speciell Schimmelpilzkeime, nach Zeit und Ort variieren, so ist wenigstens an gewissen Orten eine ein ganzes Jahr hindurch geführte statistische Untersuchung erforderlich, um nähere Kenntniss über die Luftkeime zu gewinnen.

Ausser dem theoretischen Interesse haben die statistischen Untersuchungen praktische Bedeutung bezüglich ihrer Berücksichtigung in der Gährtechnologie, Hygienie, Pathologie u. s. w. Von diesem Standpunkte aus übernahm ich die Arbeit und führte von Anfang Mai 1901 bis Ende Mai 1902, also ein ganzes Jahr<sup>1)</sup> hindurch, Untersuchungen aus, deren Ergebnisse ich in folgenden Kapiteln zusammenstelle. Es sei mir gestattet meinem hochehrten Lehrer Herrn Prof. Dr. MIYOSHI an dieser Stelle für seine vielseitigen Anregungen und Unterstützungen meinen verbindlichsten Dank auszusprechen.

Die Fragen, welche durch meine Untersuchungen gelöst werden sollten, waren folgende :

- 1) Wie viele Keime von Schimmelpilzen sind in der Luft vorhanden, und wie variieren dieselben nach den Jahreszeiten?
- 2) Welche Arten sind in der Luft vorhanden, und in welcher Weise variieren diese nach Ort und Zeit?

Während meine Arbeit im Gange war, erschien ein Aufsatz von SHIBUYA<sup>2)</sup>, welcher die Luftkeime an verschiedenen Orten Tokios untersucht und zahlreiche Bakterien- und Schimmelpilzkolonien gefunden hatte. Seine Versuche haben sich aber nicht auf ein ganzes Jahr erstreckt, sondern wurden nur im Zeitraume von Oktober 1900 bis December desselben Jahres ausgeführt.

---

1) Während ich mit der Arbeit beschäftigt war, zwang mich leider ein Unfall dieselbe während des Augusts 1901 einzustellen. Dieser Monat wird also in der Arbeit nicht erwähnt werden.

2) SHIBUYA, S., Ueber das Vorkommen der Mikroorganismen in der Luft. Mittheilungen d. medic. Gesellschaft zu Tokio, Bd. XVI, 3 Heft (Japanisch).



Ueber die qualitative sowie quantitative Analyse der Schimmelpilzflora der Luft sind wir durch seine Angaben nicht näher unterrichtet.

In der vorliegenden Untersuchung beschäftigen wir uns nur mit Schimmelpilzen, während Bakterien und Hefen in einer bald darauf folgenden Arbeit behandelt werden sollen.

## II. Methodisches.

Obschon bei der Bestimmung der in der Luft suspendierten kleinen Körperchen mannigfaltige Methoden seitens früherer Forscher empfohlen worden sind<sup>1)</sup>, diente mir für meine sämtlichen Versuche die Aussetzung einiger PETRI'schen Schalen, die mit Nährgelatine beschickt waren.<sup>2)</sup>

Der angewandte Nährboden für die Entwicklung der aufgefangenen Keime war die Soyagelatine, welche neuerdings von Prof. MIYOSHI<sup>3)</sup> als ein vortrefflicher Nährboden für Schimmelpilze in Anwendung gebracht wurde.<sup>3)</sup> Da andere Luftkeime als Schimmelpilze ausserhalb des Zweckes vorliegender Untersuchung

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1) MIQUEL, I. C.; PETRI, R. J., Eine neue Methode, Bakterien und Pilzsporen in der Luft nachzuweisen und zu zählen. Zeitschr. f. Hygienie, Vol. 3, 1887, p. 1-145; FRANKLAND, New method for determining the number of mikroorganisms in air. Proc. Roy. Soc. XII. HESSE: Ueber quantitative Bestimmung der in der Luft enthaltenen Mikroorganismen. Mittheilung d. königl. Gesundheitsamtes, Bd. II, 1884. u. s. w. Da der Einwurf gegen die MIQUEL'schen Aufsammlungsmethode erhoben werden konnte, ob die aufgefangenen Keime noch entwicklungsfähig sind, oder ob sie nicht schon ihre Keimfähigkeit völlig verloren haben, so sind von mir die entwicklungsfähigen Keime allein auf der Nährgelatine gerechnet worden.

2) Aus keinem anderem Grunde als dem der Bequemlichkeit benutzte ich die Schalenansetzungsmethode, trotz der Empfehlung KOWALEWSKY's (Die Methode der quantitativen Bestimmung niederer Organismen in der Luft, 1885. Ref. in Bot. Jahresbericht, 1888, Bd. XVI, I, p. 230), dass das ruhige Niedersinkenlassen der Bakterien aus der Luft bei vergleichenden Bestimmungen dem Aspirieren vorzuziehen sei.

3) Anwendung japanischer Soya und deren Gemisch auf Pilzkultur. Bot. Mag. Tokio, Bd. IX, p. 403.

lagen, so wählte ich einen Nährboden, welcher für die Entwicklung der Letzteren passt, aber gleichzeitig für Bakterien ungünstig ist; zu dem Ende wandte ich die Soyagelatine mit gutem Erfolge an. Der von mir verwandte Nährboden enthielt die folgenden Konzentrationsverhältnisse der Mischsubstanzen:—

Soya (im Handel)	5 cem.
Koncent. Zwiebeldekot	10 „
Rohrzucker	5 gram.
Leitungswasser	85 cem.
Gelatine*	7-15 %.

Nach der Aussetzung in der Luft wurden die Schalen in Zimmertemperatur (ca. 18°C. im Mittel) gebracht, und bei kälteren Jahreszeiten ins Treibhaus (16-21°C.) versetzt. Die Inkubationszeit dauerte ca. eine Woche. Nachdem die auf der Gelatine entwickelten Schimmelpilzkolonien gezählt waren, wurde die gesammte Anzahl in den Schalen auf eine bestimmte Flächengrösse und Aussetzungsdauer (60 qcm. und 10 Minuten)<sup>1)</sup> umgerechnet, um Vergleiche zu erleichtern.

Diejenigen Schimmelpilze, welche auf dem oben erwähnten Nährgelatineboden nicht zum Fruktificieren kamen, wurden in andere Nährböden, wie Fleischpeptonagar, Brot u. s. w. wieder eingimpft; bei einigen Arten fand nach der Transplantation eine reichliche Bildung des Fruktifikationsorgans statt, bei anderen aber nicht.

Bei den statistischen Untersuchungen habe ich mich bemüht, sowohl die Luft von gleichen Lokalitäten zu untersuchen, als auch gleichzeitig die Luft von verschiedenartigen Lokalitäten mit

---

1) Diese Flächengrösse und Aussetzungsdauer wählte ich aus Bequemlichkeit zwecken für die Berechnung. Die von mir angewandte PETRI'sche Schale hält ca. 6 qcm. im Mittel.

einander zu vergleichen. Folgende waren die Orte, deren Luft untersucht wurde:—

- A) Der hiesige botanische Garten.
- B) Die Strasse zu Kanda.
- C) Die Seefläche.
- D) Der Operationssaal der chirurgischen Klinik.
- E) Der Kloakenraum des botanischen Instituts.
- F) Das Vorlesungszimmer einer Mittelschule zu Kanda.

### III. Specieller Teil.

#### A. GARTEN.

1901.

Mai.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des „Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
1	3½ p.m. 10	10.5	Schwach	Regen.	752.3	5	10	41	82	
3	3 p.m. 13	17.8	„	Trüb, etwas Regen.	758.0	„	„	68	136	
4	5 p.m. 15	23.0	Ziemlich stark (Süd.)	Klar.	765.8	„	„	95	190	
5	4 p.m. 21	20.0	„	Trüb.	755.4	„	„	60	120	Morgens klar.
6	2½ p.m. 24	22.0	Still	Klar.	748.7	„	„	91	182	Tags vorher Regen.
8	9½ a.m. 31	22.0	„	„	760.0	„	„	62	124	Letzte Nacht Regen und Gewitter.

Meteorologische Daten dieses Monates:

Barometer-Stand

758.9

1) Die relative Zahl giebt die Berechnung auf 60 qcm. und 10 Minuten an.

Temperatur	16°C
Humidität	78.0
Regenmenge	149.3
Wind { Schnelligkeit	3.9
{ Richtung	SSO
Monatsmittel der Pilzkeime	139.0 <sup>1)</sup>
Maximaler Keimgehalt	190.0
Minimaler Keimgehalt	82.0

Bei den sämtlichen Versuchen in diesem Monate wurden *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Verticillium glaucum*, *Botrytis cinerea*, *Aspergillus glaucus*, *Mucor racemosus*, *Macrosporium cladosporioides*, *Monilia* sp. und *Pyknidenbildner* gefunden, und zwar in folgenden Verhältnissen<sup>2)</sup>:—

Versuchsnummer Artenname	1		3		4		5		6		8	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .	21	42	27	54	38	76	30	60	49	98	36	72
<i>Penicillium glaucum</i> ...	1	2	5	10	15	30	3	6	2	4	1	2
<i>Epicoccum pu. purascens</i> .	1	2					4	8	15	30	18	36
<i>Botrytis cinerea</i> .....	12	24			11	22	5	10	8	16	1	2
<i>Verticillium glaucum</i> ...									5	10	1	2
<i>Aspergillus glaucus</i> .....					1	2	2	4				
<i>Mucor racemosus</i> .....									2	4		
<i>Macrosporium clado-</i> <i>sporioides</i> .....			29	58	15	30	14	28	8	16	2	4
<i>Monilia</i> sp. ....	6	12	6	12	8	16	2	4	2	4	3	6
<i>Pyknidenbildner</i> .....			1	2								

1) Diese und andere Vergleichszahlen beziehen sich auf die zehnte Kolumne (Relative Zahl). Ebenso weiterhin.

2) A. Z. = Absolute Zahl (gefundene Zahl)

R. Z. = Relative Zahl (umgerechnete Zahl)

## Juni.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
9	3½ p.m. 1	22.0	Ziemlich stark.	Klar.	763.4	5	10	182	364	
11	4 p.m. 4	13.0	Schwach.	Trüb, etwas Regen.	760.2	„	7	33	94	
12	4½ p.m. 5	22.0	„	Trüb.	761.8	„	10	39	78	
13	1½ p.m. 8	24.5	„	Klar.	751.4	3	„	105	350	Beginn der Regen- periode.
15	11 a.m. 14	23.0	Ziemlich stark.	„	755.3	„	9	101	374	
16	5½ p.m. 14	21.5	„	„	753.6	„	„	72	267	
17	3 p.m. 15	21.0	Still.	Trüb.	749.3	„	10	33	110	Vormit- tags starker Regen.
19	3¼ p.m. 20	26.0	Ziemlich stark.	Klar.	754.0	„	„	71	237	
20	Mittag 23	22.5	Still.	Trüb.	754.2	„	„	54	180	Tags vorher Regen.
22	2¼ p.m. 27	26.8	Ziemlich stark.	„	757.8	„	„	74	247	Letzte Nacht starker Regen.

Meteorologische Daten dieses Monats :—

Barometer-Stand	756.1
Temperatur	20.6°C
Humidität	82.0
Regenmenge	172.1
Wind { Schnelligkeit	3.4
{ Richtung	SSO
Monatsmittel der Pilzkeime	230.0
Maximaler Keimgehalt	374.0
Minimaler Keimgehalt	78.0

Bei den sämtlichen Versuchen in diesem Monate wurden *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Botrytis cinerea*, *Verticillium glaucum*, *Aspergillus glaucus*,

*A. giganto-sulphureus* nov. sp.<sup>1)</sup>, *Mucor racemosus*, *Macrosporium cladosporioides*, *Pestalozzia* sp. und *Pyknidenbildner* gefunden, und zwar in folgenden Verhältnissen:—

Versuchsnummer Artenname	9		11		12		13		15		16		17		19		20		22	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> ...	91	182	18	51	15	30	32	107	26	96	26	96	15	50	42	140	22	73	21	70
<i>Penicillium glaucum</i> .....	10	20	2	6	4	8	6	20	6	22	2	7	2	7	5	17	3	10	2	7
<i>Epicoecum purpurascens</i> ...	73	146	8	23	8	16	34	113	52	193	15	56	9	30	6	20	6	20	16	53
<i>Brytis cinerea</i> .....	8	16	3	9	5	10	10	33	5	19	4	15	1	3			12	40	2	7
<i>Verticillium glaucum</i> .....			1	3			1	3											3	10
<i>Aspergillus glaucus</i> .....							1	3					1	3	4	13				
<i>A. giganto-sulphureus</i> .....							2	7												
<i>Mucor racemosus</i> .....					2	4	1	3					1	3						
<i>Macrosporium cladosp.</i> ...					4	8	16	53	12	45	24	89	1	3	7	23	3	10	12	40
<i>Pyknidenbildner</i> .....																	3	10	2	7
<i>Pestalozzia</i> sp. ....																			2	7

## Juli.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Filzkolonien	Relative Zahl	Bemerkungen
24	2 p.m. 4	26.0	Schwach	Trüb.	759.4	3	8	64	267	
26	3 p.m. 8	18.5	Still	Trüb, Regen.	757.1	„	6	38	211	
28	2½ p.m. 15	18.5	„	Starker Regen.	754.4	„	„	45	250	
30	1½ p.m. 19	20.5	Schwach	Trüb.	756.2	„	„	77	428	

Meteorologische Daten dieses Monats:—

1) Ueber die Beschreibung dieser und anderer neuer Arten vergleiche den Anhang des Abschnitts V.



Barometer-Stand	756.4
Temperatur	22.1°C
Humidität	88.0
Regenmenge	229.0
Wind { Schnelligkeit	2.8
{ Richtung	SSO
Monatsmittel der Pilzkeime	289.0
Maximaler Keimgehalt	428.0
Minimaler Keimgehalt	211.0

Bei den Versuchen wurden *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Botrytis cinerea*, *Aspergillus glaucus*, *A. nidulans*, *A. caesiellus* nov. sp., *Sepedonium chrysospermum*, *Botryosporium pulchrum*, *Mucor racemosus*, *Macrosporium cladosporioides*, *Catenularia fuliginea* nov. sp., *Pestalozzia* sp. und *Heterobotrys* sp. gefunden, und zwar in folgenden Verhältnissen :—

Versuchsnummer Artenname	24		26		28		30	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	27	113	17	94	17	94		
<i>Penicillium glaucum</i> .....	7	29	3	17	10	56		
<i>Epicoccum purpurascens</i> .....	9	38	7	39	1	6		
<i>Botrytis cinerea</i> .....	3	13			8	44		
<i>Aspergillus glaucus</i> .....	4	17	1	6	2	11		
<i>A. nidulans</i> .....					1	6		
<i>A. caesiellus</i> .....					1	6		
<i>Sepedonium chrysospermum</i> ...			3	17				
<i>Botryosporium pulchrum</i> .....			1	6				
<i>Mucor racemosus</i> .....	3	13						
<i>Macrosporium cladosp rioides</i> .	3	13	3	17	2	11		
<i>Catenularia fuliginea</i> .....	4	17						
<i>Pestalozzia</i> sp. ....	2	8						
<i>Heterobotrys</i> sp. ....			3	17				

## September.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
31	1½ p.m. 18	24.0	Still	Klar.	763.1	5	10	102	204	
32	1 p.m. 21	23.5	Schwach	Starker Regen.	751.8	„	„	69	138	
33	2 p.m. 26	22.0	Still	Trüb.	759.1	„	6	75	250	

Meteorologische Daten dieses Monates :—

Barometer-Stand	758.5
Temperatur	22.3°C
Humidität	80.0
Regenmenge	130.8
Wind { Schnelligkeit	3.2
{ Richtung	NNW
Monatsmittel der Pilzkeime	197.0
Maximaler Keimgehalt	250.0
Minimaler Keimgehalt	138.0

Folgende Arten waren vorhanden :—

*Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Botrytis cinerea*, *Verticillium glaucum*, *Aspergillus glaucus*, *Asp. flavus*, *Epicoccum nigrum*, *Mucor Mucedo*, *Macrosporium cladosporioides*, *Monilia* sp., *Oospora* I, *Catenularia fuliginea*, *Pestalozzia* sp. und *Heterobotrys* sp. Die folgende Tabelle zeigt den Aufschluss ihres Vorkommens.

Versuchsnummer Artenname	31		32		33	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	34	68	13	26	33	110
<i>Penicillium glaucum</i> .....	9	18	2	4	8	27
<i>Epicoccum purpurascens</i> .....	19	38	2	4		
<i>Botrytis cinerea</i> .....	1	2	8	16		
<i>Epicoccum nigrum</i> .....	1	2				
<i>Verticillium glaucum</i> .....	4	8	1	2		
<i>Aspergillus glaucus</i> .....	1	2			4	13
<i>A. flavus</i> .....					3	10
<i>Mucor Mucedo</i> .....			1	2		
<i>Macrosporium cladosporioides</i> ...	6	12	2	4		
<i>Monilia</i> sp. ....	1	2				
<i>Pestalozzia</i> sp. ....	2	4				
<i>Catenularia fuliginea</i> .....					2	7
<i>Oospora</i> I. ....	1	2				
<i>Heterobotrys</i> sp. ....	1	2			1	3

## Oktober.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
35	11 a.m. 2	19.2	Schwach	Klar.	765.1	5	9	103	229	Tags vorher schwül.
36	Mittag 6	21.0	Still	Etwas Regen.	760.9	"	10	350	700	
37	5 p.m. 10	24.0	"	Klar.	760.4	"	"	129	258	
39	3 p.m. 14	"	Schwach	"	755.2	"	"	165	330	Schwül, bisweilen starker Regen.
40	2½ p.m. 16	21.0	"	Trüb.	762.4	"	"	36	72	
41	2 p.m. 18	10.5	Stark	Starker Regen.	766.6	"	"	94	188	
43	4 p.m. 22	17.5	Still	Klar.	772.3	"	6	33	110	Morgen starker Regen.
44	2 p.m. 28	18.0	Ziemlich stark	Trüb.	759.9	"	10	64	128	

## Meteorologische Daten dieses Monates :—

Barometer-Stand	762.5
Temperatur	16.8°C
Humidität	83.0
Regenmenge	311.1
Wind { Schnelligkeit	3.5
{ Richtung	NNW
Monatsmittel der Pilzkeime	252.0
Maximaler Keimgehalt	700.0
Minimaler Keimgehalt	72.0

Bei den Versuchen in diesem Monate wurden *Cladosporium herbarum*, *Penicillium glaucum*, *Botrytis cinerea*, *Verticillium glaucum*, *Epicoccum purpurascens*, *Fusarium roseum*, *Aspergillus glaucus*, *A. flavus*, *A. nidulans*, *Oedocephalum crystallinum*, *Mucor racemosus*, *Rhizopus nigricans*, *Catenularia fuliginea*, *Glenospora* sp., *Macrosporium cladosporioides*, *Monilia* sp., *Heterobotrys* sp., *Pestalozzia* sp., *Cylindrocephalum* sp. und *Pyknidenbildner* constatiert. Ueber ihr Vorkommen in den Versuchsreihen giebt folgende Tabelle Aufschluss :—

[illegible]

## November.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
46	3 p.m. 4	15.0	Still	Klar.	771.3	5	10	29	58	
48	11 a.m. 9	17.0	Schwach	„	766.2	„	„	47	94	Letzte Nacht Regen.
52	1½ p.m. 16	11.0	Fast still	Trüb.	759.7	„	8	34	85	„
53	3½ p.m. 20	13.0	Stark (West)	Klar.	754.1	„	10	89	178	
55	3 p.m. 25	10.0	Sehr stark (Nord)	„	755.8	„	„	215	430	Morgens Frost.
57	3 p.m. 29	„	Schwach	„	756.5	„	„	26	52	

Meteorologische Daten dieses Monats :—

Barometer-Stand	762.5
Temperatur	10.2°C
Humidität	74.0
Regenmenge	63.6
Wind { Schnelligkeit	3.2
Wind { Richtung	NNW
Monatsmittel der Pilzkeime	150.0
Maximaler Keimgehalt	430.0
Minimaler Keimgehalt	52.0

Die gefundenen Pilze sind folgende :—

*Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Aspergillus glaucus*, *A. nidulans*, *Fusarium roseum*, *Macrosporium cladosporioides*, *Cephalothecium roseum*, *Catenularia fuliginosa*, *Oedocephalum crystallinum*, *Pestalozzia* sp., *Acremonium*



*alternatum*, *Monilia* sp., *Heterobotrys* sp., *Dematium pullans* und *Pyknidenbildner*, und zwar in folgendem Verhältnisse:—

Versuchsnummer Artenname	46		48		52		53		55		57	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .	7	14	8	16	11	28	36	72	109	218	9	18
<i>Penicillium glaucum</i> ...	2	4	3	6	2	5	2	4	1	2	4	8
<i>Epicoccum purpurascens</i> .			2	4	1	3	2	4			1	2
<i>Aspergillus glaucus</i> .....	1	2										
<i>A. nidulans</i> .....			1	2	3	8						
<i>Fusarium roseum</i> .....			1	2			4	8				
<i>Macrosporium clado-</i> <i>sporioides</i> .....	3	6	3	6	3	8	4	8			2	4
<i>Cephalothecium roseum</i> .			1	2								
<i>Cutnellaria fuliginea</i> ...			3	6								
<i>Oedocephalum crystal-</i> <i>linum</i> .....					1	3						
<i>Pestalozzia</i> sp. ....			1	2	1	3	4	8			1	2
<i>Monilia</i> sp. ....			1	2							1	2
<i>Dematium pullans</i> .....							3	6				
<i>Acremonium alternatum</i> .			1	2								
<i>Heterobotrys</i> sp. ....	10	20	5	10	8	20	12	24	1	2	2	4
<i>Pyknidenbildner</i> .....	1	2					1	2			1	2

## December.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Ansetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
58	3 p.m. 2	9.3	Still	Trüb.	747.7	5	6	24	80	Morgens starker Regen.
59	3 p.m. 6	15.5	Stark (West)	Klar.	753.9	„	10	242	484	
60	3 p.m. 11	11.5	Stark (Nord)	„	761.4	„	9	83	184	Fort- gesetzt klares Wetter.
62	2½ p.m. 16	13.5	Fast still	„	762.1	„	10	25	50	
64	2 p.m. 23	8.0	Schwach	„	765.1	„	„	61	122	Morgens Frost.
66	2½ p.m. 27	7.0	Still	„	761.0	„	„	35	70	

Meteorologische Daten dieses Monates :—

Barometer-Stand	762.2
Temperatur	4.5°C
Humidität	65.0
Regenmenge	110.8
Wind { Schnelligkeit	3.4
{ Richtung	NNW
Monatsmittel der Pilzkeime	165.0
Maximaler Keimgehalt	484.0
Minimaler Keimgehalt	50.0

Bei den Versuchen wurden die folgenden Pilze gefunden :  
*Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum pur-  
 purascens*, *Mucor racemosus*, *Rhizopus nigricans*, *Aspergillus glaucus*,

*Asp. nidulans*, *Fusarium roseum*, *Verticillium tomentosulum*, *Macrosporium cladosporioides*, *Catenularia fuliginea*, *Pestalozzia* sp., *Monilia* sp., *Dematium pullans*, *Heterobotrys* sp. und *Pyknidenbildner*, und zwar in folgenden Verhältnissen:—

Versuchsnummer Artenname	58		59		60		62		64		66	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .	5	17	151	302	37	82	8	16	15	30	7	14
<i>Penicillium glaucum</i> ...	2	7	1	2	2	4	1	2	7	14	7	14
<i>Epicoecum purpurascens</i> .....			8	16	5	11	1	2				
<i>Aspergillus glaucus</i> ...									2	4	2	4
<i>A. nidulans</i> .....											2	4
<i>Mucor rufescens</i> .....			6	12								
<i>Rhizopus nigricans</i> .....			1	2	2	4						
<i>Fusarium roseum</i> .....											1	2
<i>Verticillium tomentosulum</i> .....									1	2		
<i>Macrosporium cladosporioides</i> .....					1	2	3	6				
<i>Pestalozzia</i> sp. ....									2	4		
<i>Catenularia fuliginea</i> ...											2	4
<i>Monilia</i> sp. ....					1	2			1	2		
<i>Dematium pullans</i> .....							1	2	1	2		
<i>Pyknidenbildner</i> .....			2	4	2	4	2	4	1	2		
<i>Heterobotrys</i> sp. ....	9	30					3	6	2	4	2	4

1902.

Januar.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
67	2 p.m. 6	6.0	Sehr stark (Nordwest)	Klar.	763.9	5	6	65	217	Morgens Frost.
68	4 p.m. 10	5.0	Ziemlich stark (Nord)	„	760.6	„	10	51	102	
70	2 p.m. 17	11.0	Still	„	753.3	„	„	35	70	
71	2 p.m. 22	3.0	Schwach	Schnee und Regen.	759.6	„	„	30	60	
74	2½ p.m. 29	12.0	Still	Klar.	765.7	„	„	13	26	

Meteorologische Daten dieses Monates :—

Barometer-Stand	761.7
Temperatur	2.4°C
Humidität	59.0
Regenmenge	33.4
Wind { Schnelligkeit	3.8
Wind { Richtung	NNW
Monatsmittel der Pilzkeime	95.0
Maximaler Keimgehalt	217.0
Minimaler Keimgehalt	26.0

In der Luft fanden sich *Cladosporium herbarum*, *Penicillium glaucum*, *P. leucocephalum*, *Penicillium* sp., *Epicoccum purpurascens*, *Mucor racemosus*, *Hyalopus ochraceus*, *Pestalozzia* sp., *Ovularia* sp., *Macrosporium cladosporioides*, *Catenularia fuliginca*, *Pykniden-*  
*bildner*, *Heterobotrys* sp. und *Monilia* sp., und zwar in folgenden Verhältnissen :— .

Versuchsnummer Artenname	67		68		70		71		74	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum.</i>	11	37	16	32	2	4	1	2	4	8
<i>Penicillium glaucum</i> ...	7	23	4	8	8	16	5	10	1	2
<i>P. leucocephalum</i> .....			1	2						
<i>P. sp.</i> .....					1	2				
<i>Epicoecum purpurascens.</i>			1	2						
<i>Mucor racemosus</i> .....	1	3								
<i>Hyalopus ochraceus</i> .....			1	2						
<i>Pestalozzia sp.</i> .....	1	3	2	4						
<i>Ovularia sp.</i> .....	1	3								
<i>Macrosporium eld- sporioides</i> .....					1	2				
<i>Catenularia fuliginca</i> ...			1	2					2	4
<i>Monilia sp.</i> .....									1	2
<i>Pyknidenbildner</i> .....			2	4						
<i>Heterobotrys sp.</i> .....	7	23	5	10	1	2	22	44	1	2

## Februar.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
75	1½ p.m. 5	6.5	Schwach	Klar.	763.6	5	8	60	150	Tags vorher etwas Schnee.
77	2½ p.m. 12	6.0	„	„	769.5	„	10	42	84	
79	3 p.m. 19	6.5	Stark	„	763.0	„	„	89	178	
81	2 p.m. 24	15.0	Stark (Nordwest)	Trüb.	766.1	„	„	44	88	

Meteorologische Daten dieses Monates:—

Barometer-Stand	764.6
Temperatur	3.8°C
Humidität	61.0
Regenmenge	20.9
Wind { Schnelligkeit	3.8
{ Richtung	NNW
Monatsmittel der Pilzkeime	125.0
Maximaler Keimgehalt	178.0
Minimaler Keimgehalt	84.0

In diesem Monate wurden *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Aspergillus glaucus*, *Asp. nidulans*, *Mucor racemosus*, *Macrosporium cladosporioides*, *Catenularia fuliginea*, *Pestalozzia* sp., *Heterobotrys* sp., *Monilia* sp., und *Pyknidenbildner* gefunden, und zwar in folgenden Verhältnissen:—

Versuchsnummer Artenname	75		77		79		81	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	12	30	10	20	37	74	12	24
<i>Penicillium glaucum</i> .....	8	20	9	18	9	18	4	8
<i>Epicoccum purpurascens</i> .....					11	22	1	2
<i>Aspergillus glaucus</i> .....	7	18	1	2				
<i>A. nidulans</i> .....			2	4				
<i>Mucor racemosus</i> .....					1	2		
<i>Macrosporium cladosporioides</i> .....			1	2	7	14	6	12
<i>Catenularia fuliginea</i> .....	2	5						
<i>Pestalozzia</i> sp. ....	1	3						
<i>Monilia</i> sp. ....			2	4				
<i>Pyknidenbildner</i> .....					1	2		
<i>Heterobotrys</i> sp. ....	6	15	1	2	22	44		



## März.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeildauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
83	3 p.m. 5	9.0	Schwach	Trüb.	760.8	5	8	32	80	Fortge- setzt klares Wetter.
85	2 p.m. 12	14.0	Ziemlich stark (Süd)	Klar.	765.2	„	10	46	92	
87	2 p.m. 18	21.0	Schwach	„	761.9	„	„	27	54	Tags zuvor und am Tage selbst Regen und Schnee.
88	2½ p.m. 24	7.5	Ziemlich stark (Nord)	Trüb, etwas Regen.	769.7	„	„	17	34	

Meteorologische Daten dieses Monates:—

Barometer-Stand	762.1
Temperatur	8.4°C
Humidität	71.0
Regenmenge	90.4
Wind { Schnelligkeit	4.3
{ Richtung	N
Monatsmittel der Pilzkeime	65.0
Maximaler Keimgehalt	92.0
Minimaler Keimgehalt	34.0

Bei den Versuchen wurden in diesem Monate *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Aspergillus glaucus*, *Botrytis cinerea*, *Verticillium glaucum*, *Macrosporium cladosporioides*, *Catenularia fuliginea*, *Sporotrichium laxum*, *Pestalozzia* sp., *Pyknidenbildner*, *Verticicladium* sp., *Torula* sp., *Monilia* sp. und *Heterobotrys* sp. gefunden. Die folgende Tabelle zeigt das Verhältniss ihres Vorkommens.

Versuchsnummer Artenname	83		85		87		88	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	5	13	9	18	5	10	2	4
<i>Penicillium glaucum</i> .....	9	23	4	8	2	4	2	4
<i>Epicoccum purpurascens</i> .....	1	3	3	6	2	4	1	2
<i>Botrytis cinerea</i> .....			1	2				
<i>Verticillium glaucum</i> .....					2	4	1	2
<i>Aspergillus glaucus</i> .....	2	5						
<i>Macrosporium cladosp.</i> .....	1	3			1	2		
<i>Catenularia fuliginea</i> .....	2	5	1	2	6	12		
<i>Sporotrichium laxum</i> .....			1	2			1	2
<i>Monilia sp.</i> .....			1	2	2	4		
<i>Pestalozzia sp.</i> .....					2	4		
<i>Pyknidenbildner</i> .....					1	2		
<i>Verticicladium sp.</i> .....			1	2				
<i>Torula sp.</i> .....			2	4				
<i>Heterobotrys sp.</i> .....	3	8	11	22			3	6

## April.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitraum des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pflzkolonien	Relative Zahl	Bemerkungen
90	2 p.m. 1	14.0	Schwach	Trüb.	770.5	5	8	35	88	
94	1½ p.m. 8	21.0	Ziemlich stark	Klar.	755.7	„	10	72	144	
96	1¼ p.m. 18	15.5	Still	Trüb.	765.2	„	„	27	54	Fortgesetzt klares Wetter.
98	1 p.m. 19	19.5	„	Klar.	748.9	„	9	18	40	Morgens starker Regen.
99	1 p.m. 23	15.0	Schwach	„	762.0	„	10	70	140	
101	4½ p.m. 30	21.0	Still	„	755.5	„	„	76	152	

Meteorologische Daten dieses Monates :—

Barometer-Stand	760.3
Temperatur	11.6°C
Humidität	68.0
Regenmenge	140.3
Wind { Schnelligkeit	3.9
{ Richtung	NNW
Monatsmittel der Pilzkeime	103.0
Maximaler Keimgehalt	152.0
Minimaler Keimgehalt	40.0

Folgende Pilze wurden in diesem Monate gefunden ; *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Botrytis cinerea*, *Aspergillus glaucus*, *A. nidulans*, *Verticillium glaucum*, *Macrosporium cladosporioides*, *Catenularia fuliginea*, *Sporotrichium laxum*, *Mucor racemosus*, *Ovularia sp.*, *Dematium pullans*, *Monilia sp.* und *Heterobotrys sp.*, und zwar in folgenden Verhältnissen :—

Versuchsnummer Artenname	90		94		96		98		99		101	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .	5	13	15	30	9	18	5	11	14	23	17	34
<i>Penicillium glaucum</i> ...	13	33	2	4	6	12	1	2	2	4	6	12
<i>Epicoccum purpu-</i> <i>rascens</i> .....	5	13	9	18	1	2			5	10	7	14
<i>Botrytis cinerea</i> .....	2	5	14	28			3	7	1	2	3	6
<i>Verticillium glaucum</i> ...			9	18	1	2	1	2	27	54	5	10
<i>Aspergillus glaucus</i> .....					1	2					1	2
<i>A. nidulans</i> .....	1	3									1	2
<i>Mucor racemosus</i> .....	1	3							1	2		
<i>Macrosporium clado-</i> <i>sporioides</i> .....	5	13	6	12					1	2		
<i>Ovularia</i> sp. ....											1	2
<i>Catenularia fuliginea</i> ...			1	2							3	6
<i>Monilia</i> sp. ....			1	2			5	11	10	20	3	6
<i>Dematium pullans</i> .....									2	4	2	4
<i>Sporotrichium laxum</i> ...											1	2
<i>Heterobotrys</i> sp. ....	1	3	6	12	1	2					2	4

## Mai.

No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Ansetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
102	4½ p.m. 6	22.0	Ziemlich stark	Klar.	760.3	3	10	100	333	Tags vorher Regen.
104	4 p.m. 14	19.5	Still	Starker Regen.	766.6	„	„	38	127	
106	5½ p.m. 21	22.5	„	Klar.	758.5	„	„	55	183	
107	4 p.m. 26	23.5	„	Trüb.	757.2	„	„	62	207	

Meteorologische Daten dieses Monates:—

Barometer-Stand	759.3
Temperatur	16.3°C
Humidität	78.0
Regenmenge	222.7
Wind { Schnelligkeit	4.1
{ Richtung	SSO
Monatsmittel der Pilzkeime	213.0
Maximaler Keimgehalt	333.0
Minimaler Keimgehalt	127.0

In diesem Monate wurden gefunden:—*Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Botrytis cinerea*, *Verticillium glaucum*, *Aspergillus glaucus*, *A. nidulans*, *Macrosporium cladosporioides*, *Catenularia fuliginea*, *Dendryphium* sp., *Acremonium alternatum*, *Monilia* sp., *Dematium pullans*, *Pestalozzia* sp., *Oospora* II und III, und zwar in folgenden Verhältnissen:—

Versuchsnummer Artenname	102		104		106		107	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	14	47	2	7	12	40	17	57
<i>Penicillium glaucum</i> .....	6	20			5	17	4	13
<i>Epicoccum purpurascens</i> .....	2	7			3	10	19	63
<i>Botrytis cinerea</i> .....	1	3	1	3			1	3
<i>Verticillium glaucum</i> .....	12	40						
<i>Aspergillus glaucus</i> .....	1	3	1	3				
<i>A. nidulans</i> .....	1	3	1	3				
<i>Macrosporium cladosporioides</i> .....	1	3	2	7	8	27	8	27
<i>Catenularia fuliginea</i> .....	5	17					1	3
<i>Dendryphium</i> sp. ....	1	3	2	7				
<i>Monilia</i> sp. ....	28	93	4	13			2	7
<i>Dematium pullans</i> .....	6	20	1	3				
<i>Pestalozzia</i> sp. ....	1	3						
<i>Oospora</i> II. ....							1	3
<i>Oospora</i> III. ....	2	7			8	27		
<i>Acremonium alternatum</i> .....	1	3						

Es ist aus der Reihe der monatlich ausgeführten Versuche leicht erkennbar, dass die Schimmelpilzkeime in der Gartenluft nach den Monaten mannigfaltig abwechseln. Dieses scheint sehr verschiedene Ursachen zu haben; es wird dessen noch später in den folgenden Abschnitten Erwähnung gethan. Hervorgehoben sei an dieser Stelle nur, dass der maximale Keimgehalt der Schimmelpilze im Juli und der minimale im März liegen.

Die im ganzen Jahre in der Gartenluft gefundenen Schimmelpilze waren folgende:—*Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Botrytis cinerea*, *Verticillium*



*glaucum*, *Verticillium tomentosulum*, *Mucor racemosus*, *M. Mucedo*, *Rhizopus nigricans*, *Aspergillus glaucus*, *A. nidulans*, *A. caesiellus*, *A. giganto-sulphureus*, *A. flavus*, *Macrosporium cladosporioides*, *Sepedonium chrysospermum*, *Botryosporium pulchrum*, *Catenularia fuliginea*, *Epicoccum nigrum*, *Fusarium roseum*, *Oedocephalum crystallinum*, *Glenospora* sp., *Cylindrocephalum* sp., *Cephalothecium roseum*, *Acremonium alternatum*, *Hyalopus ochraceus*, *Penicillium leucocephalum*, *Penicillium* sp., *Sporotrichium laxum*, *Ovularia* sp., *Heterobotrys* sp., *Monilia* sp., *Dematium pullans*, *Dendryphium* sp., *Torula* sp., *Oospora* I, II und III, *Verticicladium* sp., *Pestalozzia* sp. und *Pykniden* bildner.

Von denselben waren *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens* und *Macrosporium cladosporioides* die in der Gartenluft stets häufig gefundenen Arten. *Botrytis cinerea* und *Verticillium glaucum* zeigten sich nur in wärmeren Zeiten, während einige Andere wie *Fusarium roseum* und *Heterobotrys* sp. mehr in den kalten Monaten vorherrschten.

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## B. STRASSE.

In Strassenluft führte ich allmonatlich auch einige Versuche aus, um die Zahlen der Schimmelpilzkeime mit denen im Garten zu vergleichen. Hier sind sie in nachfolgender Tabelle A mit nebenbei stehenden meteorologischen Daten kurz zusammengestellt; in Tabelle B zeigt sich das Vorkommenverhältniss der daraus gefundenen Arten.

Tabelle A.

Monat	No.	Datum	Temp. in C°	Wind	Wetter	Barometer- Stand	Zeitdauer des Ansetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pitzkolonien	Relative Zahl	Monatsmittel
6	18	11 a.m. 20	23.0	Stark und staub- führend.	Klar.	755.9	2	6	300	2500	4550
	21	10 <sup>2</sup> / <sub>3</sub> a.m. 25	23.5	Still.	Trüb.	751.8	<sup>1</sup> / <sub>6</sub>	"	66	6600	
7	23	10 a.m. 2	20.2	Schwach.	Regen.	755.9	<sup>1</sup> / <sub>6</sub>	"	87	8700	35950
	25	10 a.m. 6	19.0	"	"	755.9	"	"	reich	—	
	27	10 a.m. 11	19.6	Still.	Trüb und Regen.	760.6	"	"	reich	—	
	29	8 a.m. 18	19.8	"	Trüb.	754.6	"	"	632	63200	
9	34	11 a.m. 27	16.1	"	"	766.1	<sup>1</sup> / <sub>6</sub>	"	40	4000	4000
10	33	11 a.m. 11	15.2	Schwach.	Klar.	763.6	<sup>1</sup> / <sub>6</sub>	"	82	8200	4333
	42	11 a.m. 22	13.7	"	"	771.1	"	"	26	2600	
	45	11 a.m. 29	11.8	"	Trüb.	771.0	"	"	22	2200	
11	47	11 a.m. 5	10.3	"	"	769.2	<sup>1</sup> / <sub>6</sub>	"	14	1400	1780
	50	1 <sup>1</sup> / <sub>2</sub> p.m. 12	17.9	"	Klar.	762.0	"	"	26	2600	
	54	11 a.m. 21	7.9	Fast still.	"	758.3	"	"	23	2300	
	56	11 a.m. 28	7.7	Schwach.	"	748.6	1	<sup>2</sup> / <sub>5</sub>	41	820	
12	61	11 a.m. 12	7.0	Ziemlich stark.	"	764.7	1	6	72	1200	961
	63	Mittag 19	1.0	Schwach.	Zuerst Schnee dann Regen.	669.4	"	"	56	933	
	65	8 <sup>1</sup> / <sub>2</sub> a.m. 25	4.9	"	Regen.	764.1	"	"	45	750	
1	69	Mittag 14	4.1	Schwach.	Klar.	760.9	1	"	31	517	856
	72	" 23	3.9	Still.	Trüb.	755.6	"	"	43	717	
	73	2 <sup>1</sup> / <sub>2</sub> p.m. 28	8.1	Fast still.	Klar.	765.3	"	"	80	1333	
2	76	Mittag 6	3.1	Schwach.	"	763.7	1	"	78	1300	700
	78	2 <sup>1</sup> / <sub>2</sub> p.m. 13	0.7	Still.	Schnee.	759.7	"	"	52	867	
	80	2 <sup>1</sup> / <sub>2</sub> p.m. 19	6.7	"	Trüb.	763.0	"	"	20	333	
	82	2 <sup>1</sup> / <sub>2</sub> p.m. 27	12.4	Schwach.	Klar.	768.8	"	"	18	300	
3	84	2 <sup>1</sup> / <sub>2</sub> p.m. 6	10.7	"	Klar, etwas staubig.	764.0	1	"	27	450	389
	86	<sup>1</sup> / <sub>2</sub> p.m. 15	13.7	"	Klar.	757.8	"	"	28	467	
	89	11 a.m. 29	10.3	Etwas staub- führend.	"	768.2	"	"	15	250	
4	95	10 <sup>1</sup> / <sub>2</sub> a.m. 10	9.8	Still.	Trüb.	746.7	1	"	23	383	458
	100	1 <sup>1</sup> / <sub>2</sub> a.m. 29	14.5	"	Etwas Regen.	762.0	"	"	32	533	
5	103	2 <sup>1</sup> / <sub>2</sub> p.m. 8	16.8	Schwach.	Starker Regen. Von	752.8	1	"	80	1333	2850
	105	2 <sup>1</sup> / <sub>2</sub> p.m. 15	16.6	Still.	1 <sup>1</sup> / <sub>2</sub> –2 p.m. Starker Regen.	766.2	"	"	262	4367	

### Tabelle B.

Versuchsnummer -Artenname	18	21	23	25	27	29	34	38	42	45	47	50	54	56	61
<i>Chaetosporium herbarum</i> .....	A.Z.	R.Z.	A.Z.	R.Z.		A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	A.Z.	R.Z.	A.Z.	R.Z.	R.Z.
<i>Penicillium glaucum</i> .....	50 417	6 600	1 100		200	4 400	6 600	10 1000	10 1000	4 400	4 400	16 1600	9 900	22 440	18 300
<i>Epicoccum purpurascens</i> , <i>Verticillium glaucum</i> .....	5 42 20 167	32 3200	55 5500	reich.	67	6700 505	505 500	16 1600	1 100		2200 1 100	4 400	4 400	7 140	4 67
<i>Aspergillus glaucus</i> .....															
<i>A. nidulans</i> .....		5 500	17 1700		29	2900	6 600	3 300					1 100	2 40	5 83
<i>A. albus</i> .....						69	6900	1 100	3 300		1 100		1 100	3 60	2 33
<i>Mucor racemosus</i> .....															
<i>Rhizopus nigricans</i> .....	4 33		3 300												
<i>Catenularia fuliginosa</i> ..	2 17	25 2300	6 600	reich.	214 21400	48	4800	4 400	31 3100	1 100	1 100			2 40	2 33
<i>Macrosporium elado-</i> <i>sporoides</i> .....			5 500				1 100				3 300		1 100		
<i>Monilia sp.</i> .....												1 100			
<i>Dematium pullans</i> .....									4 400						
<i>Oedocephalum crystallinum</i> ,								1 100							3 50
<i>Dendryphium penicillioidum</i> ,								1 100	1 100						
<i>Heterobotrys sp.</i> .....															
<i>Pestalotzia sp.</i> .....							1 100	2 200		1 100		1 100	3 300		1 17
<i>Pyknidenbacter</i> .....															
<i>Penicillium leucocephalum</i> ....															1 17
<i>Oenlaria sp.</i> .....															
<i>Sclerotinia microsporis</i> .....															
	A.Z.	A.Z.	A.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	A.Z.	R.Z.	A.Z.	R.Z.	R.Z.
Versuchsnummer -Artenname	18	21	23	25	27	29	34	38	42	45	47	50	54	56	61



Es ergab sich, dass die Schimmelpilzkeime in Strassen- und Gartenluft bezüglich ihrer Anzahl bedeutend von einander abweichen, worauf wir in den folgenden Abschnitten noch einmal zurückkommen werden. Hier sei nur erwähnt, dass in der Strassenluft *Penicillium glaucum* und *Catenularia fuliginea* häufig und besonders in Juli 1901 am meisten zu finden waren; nächst ihnen kamen *Aspergillus glaucus* und *A. nidulans*. *Epicoccum purpurascens* und *Macrosporium cladosporioides*, die in der Gartenluft stets reichlich gefunden wurden, erschienen in dieser Versuchsreihe nur selten; merkwürdig ist auch das gänzliche Fehlen der *Botrytis cinerea*.

### C. SEE.

Während eines Aufenthaltes im April 1902 in der biologischen Station zu Misaki führte ich am 5 des Monates Versuche aus, um die Anzahl der Schimmelpilzkeime über der Seefläche, dem Strande und in dem Stationslaboratorium mit einander zu vergleichen. Hierbei erhielt ich folgende Resultate:

No.	Ort.	Temp. in C°	Wind	Wetter	Zeitdauer des Ansetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl	Bemerkungen
91	Seefläche 2 engl. Meilen entfernt vom Strande	14	Nord Schwach	Klar.	5	6	9	30	Tags vorher stark windig.
92	Strand	"	"	"	"	"	58	193	
93	Laboratorium	"	"	"	"	"	48	160	

Auffallend bei diesen Versuchen ist, dass die Seefläche sehr arm an Schimmelpilzkeimen ist gegenüber der Keimzahl der Strand- und Laboratoriumsluft. Die Anzahl der gefundenen Pilze ist hier in Tabellenform gegeben:

Versuchsnummer Artenname	91		92		93	
	A.Z.	R.Z.	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	4	13	21	70	45	150
<i>Penicillium glaucum</i> .....	3	10				
<i>Epicoccum purpurascens</i> ...			2	7	2	7
<i>Alternaria tenuis</i> .....			30	100		
<i>Dematium pullans</i> .....			1	3		
<i>Chaetocladium Johnsii</i> .....	1	3				

An dem reichlichen Vorkommen von *Cladosporium herbarum* erkennt man die Zimmerluft, wo *Penicillium glaucum* gänzlich fehlt; dieser Pilz lässt sich auch in der Strandluft nicht finden, umgekehrt ist das Verhältniss bei *Epicoccum purpurascens*.

Zu erwähnen ist noch, dass *Chaetocladium Johnsii* aus der Seeflächenluft gefangen wurde.

#### D. OPERATIONSSAAL DER CHIRURGISCHEN KLINIK.

Einmaliger Versuch um 11½ a.m. des 13. Novembers 1901. Lufttemperatur im Zimmer 17°C, äussere Temperatur 11°C. Zimmerluft sehr feucht. Wind still und Wetter trüb. Aussetzung 15 Minuten. Zahl der Schalen 6. Zahl der Kolonien insgesamt 47, darunter *Cladosporium herbarum* 22, *Penicillium glaucum* 22, *Epicoccum purpurascens* 1, *Mucor racemosus* 1, *Heterobotrys* sp. 1.



Vergleicht man die Zahlen und Arten der Pilzkolonien dieses Versuches mit den in Garten und Strasse im November angestellten Versuchen, so findet man keine nennenswerthe Verschiedenheit zwischen ihnen.

### E. KLOAKE.

Ein einmaliger Versuch wurde um 11½ a.m. des 10. Novembers 1901 im Kloakenraume des Botanischen Instituts vorgenommen. Lufttemperatur 17.5°C. Wind still und Wetter klar. Aussetzung 10 Minuten. Zahl der Schalen 6. Zahl der Pilzkolonien insgesamt 40, darunter *Cladosporium herbarum* 17, *Penicillium glaucum* 1, *Epicoccum purpurascens* 3, *Macrosporium cladosporioides* 2 und *Heterobotrys* sp. 3. Eine besondere Eigenthümlichkeit der Pilzkeimverbreitung in der Kloakenluft sieht man hier nicht.

### F. VORLESUNGSZIMMER EINER MITTELSCHULE IN KANDA.

Zweimaliger Versuch am 4 und 11 Juni 1901. Die meteorologischen Daten und die Kolonienzahl von Schimmelpilzen waren folgende :

No.	Datum	Temp. in C°	Wind	Wetter	Zeitdauer des Aussetzens der Schalen in Minuten	Zahl der Schalen	Zahl der Pilzkolonien	Relative Zahl
10	11 a.m. 4	15	Schwach	Starker Regen.	5	6	19	63
11	11 a.m. 11	20	„	Klar.	„	„	„	„

Obwohl die gesammte Kolonienzahl sowie die Artenzahl in beiden Versuchen gleich war, so waren doch die Kolonienzahlen jeder Art von einander verschieden, wie man aus der folgenden Tabelle sieht.

Versuchsnummer Artenname	10		11	
	A.Z.	R.Z.	A.Z.	R.Z.
<i>Cladosporium herbarum</i> .....	8	27	16	53
<i>Penicillium glaucum</i> .....	10	33	1	3
<i>Epicoccum purpurascens</i> ...	1	3	2	7

### III. Allgemeines über die periodischen Variationen der Keimzahlen.

Da die Pilze nur dann zur Entwicklung kommen können, wenn ihnen gewisse organische Substanzen dargeboten werden, so wird das Vorhandensein eines geeigneten Substrats die Entwicklung bedeutend fördern. Doch können die Pilze auch mit guter Nahrung allein nicht zu üppigem Gedeihen gelangen, falls andere Bedingungen, insbesondere Wärme, Feuchtigkeit u. s. w. für sie nicht in günstigem Maasse vorhanden sind. Dieses erklärt, warum in gewissen Zeitabschnitten die Pilzkeime der Luft sowohl in Zahl wie Art sehr häufig sind, während sie sich in anderen Perioden viel weniger zeigen. Folgende Tabelle zeigt die Keimzahl in jedem Monate und nebenbei die betreffende Temperatur, Humidität und Regenmenge. (Vergl. auch die graphische Darstellung am Ende der Arbeit.)

		Relative Anzahl in		Temperatur in C°.	Humidität	Regen- menge	Wind- Richtung
		Garten	Stras-se				
1901	{ Mai	139	—	16.0	78	149.3	S S O
	{ Juni	230	4550	20.6	82	172.1	S S O
	{ Juli	289	35950	22.1	88	229.0	S S O
	{ August	—	—	25.0	82	53.8	S S O
	{ September	197	4000	22.3	80	130.8	NNW
	{ Oktober	252	4333	16.8	83	311.1	NNW
	{ November	150	1780	10.2	74	63.6	NNW
	{ December	165	961	4.5	65	110.8	NNW
1902	{ Januar	95	856	2.4	59	33.4	NNW
	{ Februar	125	700	3.8	61	20.9	NNW
	{ März	65	389	8.4	71	90.4	N
	{ April	103	458	11.6	68	140.3	NNW
	{ Mai	213	2850	16.3	78	222.7	S S O

Leicht erkenntlich ist aus dieser Tabelle, dass Wärme und Feuchtigkeit der Luft auf den Gehalt an Schimmelpilzkeimen einen wichtigen Einfluss haben. Von Mai bis Juni, als die Lufttemperatur und Humidität allmählich zunahmen, begann die Zahl der Schimmelpilzkeime der Gartenluft sich zu vermehren. Den höchsten maximalen Keimgehalt 289 an Schimmelpilzen erreichte der Juli, als die Humidität der Luft am grössten geworden und die Wärme sehr hoch gestiegen war. Trotz dem fast gleichen Temperaturmittel im September wie im Juli, wird wegen der plötzlichen Abnahme der Humidität der mittlere Keimgehalt an Schimmelpilzen bis zu 197 zu sinken veranlasst. Wenn im Oktober auch eine niedrigere Temperatur herrscht, begegnet man hier doch ganz umgekehrten Verhältnissen, deren Grund vielleicht in der höheren Humidität der Luft liegt. Von November bis

December begann wieder ein plötzlicher Abfall der Kurve in Bezug auf die Keimzahl, offenbar infolge der niedrigen Temperatur und abnehmenden Humidität.

Im Januar und Februar 1902 nahm die Keimzahl durch niedrige Temperatur und Humidität beträchtlich ab und diese beiden Monate stehen zu Juli und Oktober geradezu im umgekehrten Verhältnisse.

Trotz der höheren Temperatur und Humidität im März im Vergleich zum Februar sank die Keimzahl auf 65, die unter meinen Versuchsreihen im Garten als die minimale der monatlichen Mittelzahlen auftritt. Die Ursache ist erstens dem Vorherrschen des Nordwindes<sup>1)</sup> und zweitens der kleineren Aufspeicherung der Keime in der Luft zuzuschreiben. Von April an stieg die Zahl wieder bedeutend, ohne Zweifel veranlasst durch höhere Temperatur und Feuchtigkeit. Wenn die Temperatur und Humidität im Mai 1902 auch mit denjenigen im vorigen Jahre in Einklang standen, zeigten sich die Schimmelpilzkeime im ersten doch mehr als im letzteren; dies beruht vielleicht auf der grösseren Regenmenge in diesem Jahre, da durch die Beobachtungen MIQUEL's ähnliche Thatsachen nachwiesen sind<sup>2)</sup>. Nach ihm nimmt der Keimgehalt der Luft an Schimmelpilzen mit der Regenmenge zu oder ab. Die letztere Ansicht wurde auch durch meine Versuche bestätigt, da die Kurve des monatlichen Pilzkeimgehalts mit der grösseren oder geringeren Regenmenge fast übereinstimmt.

Was den relativen Keimgehalt betrifft, so ist die Strassenluft im allgemeinen reichlicher besetzt als die Gartenluft, aber das

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1) Der Nordwind bringt kleinere Mengen von Luftkeimen, weil an der Nordseite dieses Gartens kein lebhafter Strassenverkehr stattfindet.

2) l. c. p. 59-60.

Erscheinen des Maximums im Juli und des Minimums im März stimmen in beiden Luftarten mit einander überein; diese Thatsache kann ferner die Angabe MIQUEL's<sup>1)</sup> bestätigen.

Wenn wir alle geschilderten Thatsachen zusammenfassen und sie mit den Angaben früherer Forscher vergleichen, so geht aus allem hervor, dass hier eine Uebereinstimmung mit denselben stattfindet, da die Wärme, Humidität und Regenmenge in ihrem Zusammenwirken hauptsächlich die Abänderung der Zahl der Schimmelpilzkeime in der Luft veranlassen.

Ausser dem ganzen Verlaufe der Veränderungen der Pilzkeime müssen noch kleinere tägliche Schwankungen in Betracht gezogen werden. So übt der Wind einen nicht geringen Einfluss aus; an windigen Tagen kommen viel mehr Schimmelpilzkeime vor, als an stillen; besonders auffallend ist dieses Verhältniss in der kälteren Jahresperiode. Die folgende Tabelle möge ein Beispiel für eine derartige Beobachtungsreihe abgeben.

I		II	
Windige Tage im Garten.		Stille oder schwach windige Tage im Garten.	
178 (Versuch 53) }	November	58 (Versuch 46)	{
400 (Versuch 55) }		94 (Versuch 48)	
		52 (Versuch 57)	
484 (Versuch 59) }	December	50 (Versuch 62)	{
184 (Versuch 60) }		70 (Versuch 66)	
217 (Versuch 67) }	Januar	26 (Versuch 74)	{
102 (Versuch 68) }			
178 (Versuch 79) }	Februar	84 (Versuch 77)	{

Nicht nur die Stärke des Windes übt auf die Keimzahl einen vermehrenden Einfluss aus, sondern seine Richtung ist auch ein

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1) Nach MIQUEL (l. c. p. 59) kommt das Maximum im Juni oder im Juli und das Minimum stets im März vor.

Faktor für die Veränderung der Keimzahlen, indem sie mit der Lufttemperatur in untrennbarem Verhältnisse steht. Man sieht aus vorstehender Tabelle (S. 37), dass die Luft in wärmeren Perioden (Mai, Juni, Juli), in welcher Zeit der SSO Wind vorherrscht, unter sonst günstigen Bedingungen weit reichlichere Keime trägt, als in den kälteren Monaten (September, Oktober, November, December, Januar, Februar, und April) mit NNW Wind. Warum im März mit N Wind der Keimgehalt der Luft minimal ist, ist schon erwähnt.

Ganz umgekehrt ist das Verhältniss bei starkem Regen sowie bei Schneefall, da die in der Luft suspendierten Keime dadurch zur Erdoberfläche mechanisch herabgeschlagen werden. MIQUEL (l. c. p. 61) schreibt hierüber: „une expérience aéroscopique, pratiquée au moment d'une chute de pluie, fournit à peine quelques spores et quelques pollens;.....” Eine Bestätigung dieser Tatsache ist auch durch die Untersuchung von SHIBUYA (l.c.) erbracht, nach welchem die Luft der Stadt Tokyo beim Regen keimfrei war.

Bei derartigen Fällen fand auch ich stets eine geringere Keimzahl, nur war in meinen Versuchen der Unterschied nicht so auffällig, wie es bei den windigen und stillen Tagen der Fall war. Hier sind einige Beispiele mit der Mittelzahl der Schimmelpilzkeime in den Monaten, in welchen die Versuche ausgeführt wurden, angegeben.

Versuchsnummer	Gefundene Keimzahl	Monatsmittel
32	138	197
41	188	252
58	80	165
71	60	95
104	127	213



Fassen wir nun die monatlichen Durchschnittszahlen nach den vier Jahreszeiten zusammen, so giebt die folgende Tabelle darüber Aufschluss.

### I. Garten.

	Sommer			Herbst			Winter			Frühjahr		
Monat .....	Juni	Juli	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	März	Apr.	Mai
Anzahl .....	230	289	—	197	252	150	165	95	125	65	103	213
Summe .....	519			599			385			381		
Mittelwerth .....	259.5			199.7			128.3			127.0		

### II. Strasse.

	Sommer			Herbst			Winter			Frühjahr		
Monat .....	Juni	Juli	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	März	Apr.	Mai
Anzahl .....	4550	35950	—	4000	4333	1780	961	856	700	389	458	2850
Summe .....	40500			10113			2517			3697		
Mittelwerth .....	20250.0			3371.0			839.0			1232.3		

Hier sieht man, dass bei Gartenluft die Mittelzahlen im Sommer am grössten sind und die im Herbst ihnen am nächsten stehen; dann folgen die Zahlen von Winter und Frühjahr. Das Verhältniss ist Sommer : Herbst : Frühjahr (und Winter)  $\doteq 2 : 1.5 : 1$ . Auch bei Strassenluft liegt das Maximum im Sommer, dann folgen Herbst, Frühjahr und Winter. Das Verhältniss ist Sommer : Herbst : Frühjahr : Winter  $\doteq 24 : 4 : 1.5 : 1$ .

In den Fluktuationen der Schimmelpilzkeime in Strasse und Garten herrscht eine grosse Uebereinstimmung bezüglich ihrer Zahlenreihe; die Mittel des ersten Ortes zeigen aber einen plötzlicheren Uebergang als die des letzteren, was aus lebhaftem

Strassenverkehre erklärt wird, vermöge dessens die Einflüsse in Betracht kommender Agentien mannigfaltig verändert werden.

### V. Einiges über die Zusammensetzung der Luftkeime.

Was die Zusammensetzung der Luftkeime im Allgemeinen betrifft, so treten *Cladosporium herbarum*, *Penicillium glaucum*, *Epicoccum purpurascens*, *Catenularia fuliginea* nov. sp. am reichlichsten auf, danach kommen *Mucor*, *Aspergillus*, *Macrosporium cladosporioides*, *Botrytis cinerea* u. s. w., und schliesslich die vielen übrigen Arten. *Dematium*, das in den HANSEN'SCHEN Luftanalysen neben *Cladosporium* als im Garten speciell hervortretend gefunden war, haben wir bei unseren Versuchen nur selten angetroffen. In Folgendem geben wir die periodischen Variationen der häufiger auftretenden Schimmelpilzkeime.

*Cladosporium herbarum*, welches durch seine olivengrünen Sporenmassen sich auszeichnet und das bei den Luftanalysen HANSEN'S und LINDNER'S am häufigsten gefunden war, wurde ebenso in unseren Versuchen jedesmal stark an Zahl gefangen. An keinem Orte fehlte es vollkommen. Auch lässt sich *Penicillium glaucum* nicht selten in Luftuntersuchungen nachweisen und sämtliche bisherigen Luftanalysen haben auch sein Vorkommen angegeben. In der Regenperiode des Jahres sieht man es fast auf allen Dingen, die eine Spur Nährsubstanz an sich tragen. Der Keim verbreitet sich in dieser Zeit überall, besonders häufig in Strassenluft. Das Vorhandensein vieler Keime von diesen beiden Pilzen noch selbst in Winterluft zeigt die starke Widerstandsfähigkeit der Pilze gegen niedere Temperaturen.<sup>1)</sup> Ferner bestärkt es die Ansicht ZOPF'S<sup>2)</sup>,

1) Nach WIESNER (Sitzungsberichte d. Wien. Akad., Bd. 68., I. 1873. P. 5) erfolgt die Keimung der Conidien von *Penicillium glaucum* schon bei 1.5—2.0°C.

2) ZOPF, Die Pilze. p. 217.

welcher dem Mycelhyphen von *Cladosporium herbarum* eine hohe Resistenz gegen Austrocknung zuschreibt.

Unter den anderen Schimmelpilzen ist der purpurrothe *Epicoccum purpurascens* nicht zu übersehen. Er tritt auch sehr häufig bei den Luftanalysen im Garten auf, aber nicht immer in der Strassenluft. Allerdings entwickelt er sich auf Soyagelatine stets steril; auf zuckerhaltigen Fleischpeptonagar wieder eingimpft beginnt er allmählich bräunlichgelbe, rauhwarzige areolierte Sporen zu bilden.

In meinen Luftanalysen begegnete ich einem Schimmelpilze sehr häufig, der einmal von LINDNER<sup>1)</sup> als der „Schokoladefarbene Pilz“ vorläufig genannt wurde. Er wird besonders riesig in Zahl von der Strassenluft isoliert. In morphologischer Hinsicht der Conidienträger und Conidienbildungsweise bin ich geneigt, ihn in die Gattung *Catenularia* einzuschliesen, deren Beschreibung im Anhange dieses Abschnitts gegeben ist.

Einige Pilze treffen wir stets in einer gewissen Jahresperiode, in anderen Zeiten dagegen nicht. Als ein Beispiel nenne ich *Botrytis cinerea*. Trotz des niederen Temperaturminimums der Sporenkeimung<sup>2)</sup> ist der Pilz in Wintermonaten nie in der Luft zu finden. Die im Sommer so zahlreich gewesenen Keime verschwanden schon im November vollständig, um nach mehrmonatlicher Abwesenheit im Winter im März wieder zum Vorschein zu kommen. Ob das Fehlen im Winter dem Mangel an zu seiner Entwickelung günstigen Pflanzentheilen zuzuschreiben ist, oder an der schwachen Widerstandsfähigkeit der jungen Keimschläuche gegen Kälte liegt, muss dahin gestellt bleiben. Doch zeigt uns die Thatsache, dass *Botrytis cinerea* das ganze Jahr

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1) Betriebskontrolle der Gährungsgewerbe. Dritte Auflage. p. 315.

2) Nach HOFFMANN (Jahrb. f. wiss. Bot. Bd. II, 1860, p. 267) ist die minimale Temperatur der Sporenkeimung 1.6°C.

hindurch nie in der Strassenluft gefunden war, die beschränkten Lebensbedingungen des Pilzes.

Bezüglich des Vorkommnisverhältnisses steht *Verticillium glaucum* nahe der vorigen Species. Ihr Keim fehlt in Gartenluft im November, December, Januar und Februar; nur selten kam der Pilz bei Strassenluft im April und Mai 1902 vor.

Zu anderen Heeren von Lebewesen stehen einige in ganz umgekehrtem Verhältnisse, d. h. sie finden sich in kälterer Zeit reichlich; z. B. *Fusarium roseum* und *Heterobotrys* sp. Wie man aus der nachstehenden Tabelle sieht, beschränkten sich diese Pilze darauf, in der kälteren Periode hervorzutreten, und zwar kam der Erstere nirgends zum Vorschein als im Oktober, November und December, auch nicht in Strassenluft. Nur in dem Fehlen des entwickelungsbegünstigenden Nährmaterials erblicken wir den Grund des begrenzten Vorkommens dieses Pilzes, jedoch nicht in Temperaturbedingungen, weil sie in höherer Temperatur wohl kultiviert werden können.

Von den Pyrenomyceten waren *Mucor racemosus* und *Rhizopus nigricans* die in unseren Versuchen häufigst vorkommenden Arten. Von diesen tritt *M. racemosus* in Gartenluft öfters auf, *Rhizopus nigricans* in der Strassenluft verhältnissmässig reichlich. *M. Mucedo*, der auf Pferdemitte vegetiert, wurde bei unseren Versuchen nur selten und *Chaetocladium Johnsii*, ein Schmarotzer auf dem *Mucor*, nur einmal in der Seeflächenluft gefunden.

Eine andere Gruppe der Schimmelpilze, *Aspergillus*, kommt gleichfalls bei unseren Versuche nicht selten vor. Neben einer Reihe älterer, gut bekannter Arten habe ich noch zwei bisher unbeschriebene Formen isoliert. Eine Uebersicht der Formen ergibt nach WEHMER<sup>1)</sup> folgendes Schema.

1) Bot. Centralbl., Bd. LXXX, 1899, p. 449.

- I. Weisse species.  
*Aspergillus albus* Willh.
- II. Gelb-braune Species.  
1) Mit einfachen Sterigmen.  
*Asp. gigante-sulphureus* nov. sp.
- III. Grüne bis grüngelbe oder gelblichgrüne Species.  
1) Grosssporige Arten, Makrosporen, nur unverzweigte Sterigmen.  
*Asp. glaucus* Link.  
*Asp. flavus* Bref.  
2) Kleinsporige Arten, Mikrosporen, Sterigmen einfach oder verzweigt.  
a) Mit zwergigen Conidienträgern.  
α) Einfache Sterigmen.  
*Asp. caesiellus* nov. sp.  
β) Verzweigte Sterigmen.  
*Asp. nidulans* Eid.

Unter diesen Arten traten am häufigsten *Asp. glaucus* und *Asp. nidulans* auf, insbesondere in der Regenperiode; die erstere ist neben *Penicillium glaucum* ein mehr oder minder heftiger Feind des Haushalts. Hier dürfte noch hinzufügen sein, in welcher Weise die anderen Arten in der Luft auftraten.

Artenname	Versuchsreihe
<i>Asp. flavus.</i>	33, 36, 37, 43 (Sep.-Okt. 1901) Garten.
<i>Asp. gigante-sulphureus.</i>	13 (Juni 1901) Garten.
<i>Asp. albus.</i>	82 (Februar 1902) Strasse.
<i>Asp. caesiellus.</i>	28 (Juli 1901) Garten.

Bei Garten- und Strassenluft nicht selten anzutreffen waren noch *Macrosporium cladosporioides*, *Monilia* sp. und ein andere mit rothbräunlichen Pykniden (vorläufig der „Pyknidenbildner“ genannt). Sie kamen aber sehr unregelmässig in Zahl vor.

Am Schlusse dieses Abschnittes sind die relativen Monatsmittel der Schimmelpilzkeime in Garten- und Strassenluft, i.e. die Zahlen auf 60 qm. Fläche bei 10 Minuten Aussetzung berechnet, angegeben.



## 1901—1902

Mopate Artenname	Mai		Jun.		Jul.		Aug.		Sep.		Okt.		Nov.		Dec.		Jan.		Feb.		Mär.		Apr.		Mai	
	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.	G.	S.
<i>Cladosporium herbarum</i> .....	67		90	509	100	233			68	600	131	800	61	835	77	289	17	259	37	183	11	78	22	225	38	225
<i>Penicillium glaucum</i> .....	9		12	1621	34	20900			16	1800	10	567	5	285	7	61	12	100	16	63	10	56	11	33	13	50
<i>Epicoecum purpurascens</i> .....	13		67	84	28				14		5		2	25	5	6	+		6		4	10	9	20	14	
<i>Botrytis cinerea</i> .....	12		15		19				6		1										1	8		2		
<i>Verticillium glaucum</i> .....	2		2						3		+										2	14	9	10	50	
<i>Aspergillus glaucus</i> .....	1		2	250	11	1733			5	300	1		+	35	1	50	172	1	5	21	1	17	1	9	2	17
<i>A. nidulans</i> .....					2	2300			100		1	133	2	65	1	39	11		1		11	1	42	2	92	
<i>A. flavus</i> .....			1						3		2															
<i>A. giganteo-sulphureus</i> .....																				4						
<i>A. albus</i> .....																										
<i>A. caesiellus</i> .....					2																					
<i>Mucor racemosus</i> .....	1		1		4						+				2		1		1	4		6	1			
<i>M. Mucalo</i> .....									1																	
<i>Rhizopus nigricans</i> .....			17		100						1				1											
<i>Catenulatia fuliginosa</i> .....			1159	6	8933				2	400	2	1007	1	35	1	33	1567		1	169	5	39	1	34	5	450
<i>Fusarium roseum</i> .....											4			2	+											
<i>Heterobotrys</i> sp. ....					6				2		8	67		13	7	39	16	33	15	17		9	4			
<i>Monilia</i> sp. ....	9								1	100	3			1	25	1	+	17	1	29	2	6	7	9	28	67
<i>Plyktenidibulwer</i> .....	+		2						100		+	100		1	100	2	39	1	50	1	21	1	6		17	
<i>Macrosporium cladosporioides</i> ...	23		27		14	167			5		7			5	75	1	+		7		1	6	5	9	16	9



Pestalozzia sp.	1	3	1	2	3	1	1	1	9	1
Dematium pullans										
Sepedonium chrysospermum										
Odocephalum crystallinum		6								
Baryosporium pulchrum		2		+	133					
Epicoccum nigrum			1							
Glenospora sp.				1						
Ocularia sp.							6	1	+	
Cephalothecium roseum					+					
Verticillium tomentosulum					+					1
Acremonium alternatum					+					
Penicillium sp.								+		
P. leucocephalum								+		9
Hyalopus ochraceus								+		
Dendryphium penicillioides								+		
Dendryphium sp.					33					3
Tortula sp.									1	
Oospira I.			1							
Oospira II.										1
Oospira III.										9
Verticillidium sp.										
Sporotrichum laxum									1	
Stysanus microsporus									1	+
Cylindrocephalum sp.				+						9

+ bedeutet die Mittelzahl unter 0.5.

### Anhang.

#### Beschreibung der neuen Arten.

##### 1) *Aspergillus giganto-sulphureus*.

Der Pilz bildet eine flockige, anfangs weisse, bald hellgelb<sup>1)</sup> erscheinende Decke auf dem Nährsubstrate. Bei älteren Kulturen geht die Färbung in Schmutzig-bräunlichgelb über. Die stattlichen Conidienträger sind ansehnlich, über ein Millimeter hoch, meist einfach, seltener verzweigt; die älteren Träger sind mit vielen Querwänden versehen. Die Wand des Conidienträgers ist glatt und farblos, meist derb; das Ende des Trägers quillt zu einer kolbenförmigen grossen Blase auf. Die stets einfachen, dicken Sterigmen sind lang (über  $\frac{1}{2}$  des Blasendurchmessers oder fast gleich demselben, „langstrahlig“) und bedecken den Blasengipfel allein. Die Conidien sind überall kugelig, glatt oder warzig, gross und vakuolenhaltig. Die vegetativen Hyphen sind ebenfalls dick und wuchern manchmal durch die Conidienträger hindurch.

Grössenverhältnisse :

Conidienträger	$\pm 1$ mm.
Stiel desselben	6–16 $\mu$ dick.
Wanddicke	2 $\mu$ .
Blase	28–32 $\mu$ im Durchmesser (kolbig).
Sterigmen	24–28 $\mu$ lang und 7 $\mu$ dick.
Conidien	8–12 $\mu$ im Durchmesser.
Vegetative Hyphen	Ca. 4 $\mu$ dick.

Fruchtkörper unbekannt. Selten.

Gasblasenentbindung auf den Kulturen in Würz und Kojiextraktlösung, gleichzeitig mit schwacher Alkoholbildung (Iodoformprobe).

---

1) Die Farbenzeichnung ist nach SACCARLO's Chromotaxia angegeben.

Affinität :—

Dieser Pilz steht in vielen Beziehungen *A. Ostianus* WEHMER nahe, jedoch unterscheidet er sich vor allem in der Farbe der Pilzdecke, da diese bei unserem Pilze von Hellgelb zu Schmutzigbräunlichgelb übergeht, während sie bei *A. Ostianus* durchaus beständig bleibt. Ferner ist die Blase bei *A. Ostianus* kugelig und scharf gegen den Trägerstiel abgesetzt, während sie bei *A. giganto-sulphureus* kolbenförmig ist. Der Conidienträger von *A. giganto-sulphureus* ist zuweilen verzweigt, dagegen fehlt bei *A. Ostianus* eine solche Verzweigung vollständig.

Von anderen morphologischen Besonderheiten sind die Sterigmen und Conidien zu erwähnen. Bei *A. Ostianus* ist die Blase von allseitig ausstrahlenden Sterigmen besetzt, dagegen bei *A. giganto-sulphureus* bedecken sie nur den Blasengipfel. Die Conidien von *A. Ostianus* sind kugelig bis oval und kleingestaltet, während die von *A. giganto-sulphureus* kugelig und grossporig sind.

## 2) *Aspergillus caesiellus*.

Diese Art zeichnet sich durch zwerghaften Wuchs ihres Conidienträgers aus. Die Farbe der Decke ist ein etwas in's Graue übergehendes Grün, welches auch lange Zeit seine Nüance behält. Der Conidienträger ist sehr kurz, seine Wand stets glatt und sehr dünn. Der Stiel geht allmählich in eine kolbige Blase über, von deren Gipfel wenige, stets einfache Sterigmen (über  $\frac{1}{2}$  des Blasendurchmessers messend) ausstrahlen. Die Letzteren schnüren lange Ketten von meist glatten, gelegentlich auch warzigen ellipsoidisch-ovalen Conidien ab (kleinsporig).

## Grössenverhältnisse :—

Conidienträger	100–200 $\mu$ .
Stiel desselben	4–6 $\mu$ dick.     •
Wanddicke	0.5 $\mu$ (dünnwandig).
Blase	12–14 $\mu$ im Durchmesser (kolbig).
Sterigmen	12 $\times$ 3 $\mu$ .
Conidien	4 $\times$ 7 $\mu$ im Durchmesser.
Vegetative Hyphen	2–4 $\mu$ dick.

Fruchtkörper unbekannt, wärmeliebende Art (in 30°C gnt wachsend). Selten.

## Affinität :—

Der zwergig wachsende Pilz ist in vielen Beziehungen *A. minimus* WEHMER nahestehend (Persistenz der Deckfarbe, Ton der Conidienfarbe, einfache Sterigmen, zwerghafte Conidienträger, höhere optimale Wachstumstemperatur u. s. w.). In anderen Punkten weicht *A. minimus* von unserem Pilze ab. Beim Ersteren geht der derbwandige Stiel fast unvermittelt in eine stets kugelige Blase über, beim Letzteren dagegen ist eine allmählich übergehende Blase vorhanden. Ferner übertrifft die Blase von *A. minimus* die Sterigmenlänge erheblich, während bei *A. caesiellus* die Länge beider Organe fast gleich ist. Die Sterigmen, welche bei *A. minimus* von der ganzen Blasenoberfläche ausstrahlen, bedecken bei *A. caesiellus* stets nur den Blasengipfel.

Beide Pilze sind auch in Grösse und Gestalt der Conidien verschieden, indem bei *A. minimus* die Conidien meist oval und 2  $\mu$  gross, bei *A. caesiellus* dieselben überall ellipsoidisch-oval und 4  $\times$  7  $\mu$  gross sind.

3) *Catenularia fuliginea*.

Dieser Pilz, der einmal von LINDNER als der „Schokoladefarbene Pilz“ vorläufig genannt wurde, ist durch seine schrotkorn-grosse, schokoladenfarbige Kolonienlagerung auf dem Nährboden ausgezeichnet. Die Kolonie ist von kleinen Conidien staubig bedeckt; die letzteren stammen von kettenförmigen Abschnürungen des Endes des Conidienträgers und zerfallen leicht in einzelne Gliederzellen. Die Conidien sind ursprünglich kurz cylindrisch, später aber runden sie sich ab und werden 2–3  $\mu$  gross. Beim Keimen quellen sie enorm auf. Die kriechenden ca. 3  $\mu$  dicken vegetativen Hyphen sind anfangs farblos und in ihrer Contour gleichmässig, aber mit dem Alter wird die Letztere unregelmässig, und sowohl die ältere Hyphe als die Conidien nehmen bald die schokoladenartige Farbe an.

Die vorstehende Art unterscheidet sich von allen anderen Arten<sup>1)</sup> der Gattung durch die Grösse und Farbe der Conidien.

## VI. Zusammenfassung.

1) Durch die von mir angewandte Methode können die in der Luft suspendierten, entwicklungsfähigen Schimmelpilzkeime leicht gefangen und gezählt werden. Durch die entwicklungshemmende Wirkung der Soyagelatine in Bezug auf die Bakterien wird die Behandlung bedeutend erleichtert.

2) Was die Anzahl von Schimmelpilzkeimen zu den verschiedenen Jahreszeiten betrifft, so bestätigten sich hauptsächlich die Angaben MIQUELS. Meine Versuche ergaben:—Die Gartenluft enthielt in verschiedenen Perioden eine verschiedene Anzahl von Schimmelpilzkeimen. In den warmen und feuchten Jahreszeiten,

1) Bisher sind *C. simplex*, *C. atra* und *C. echinata* beschrieben.

d. h. besonders im Juli, sind die Pilzkeime am zahlreichsten, während sie in kalten und trockenen Zeiten dagegen geringer an Zahl sind, und im März den minimalen Gehalt erreichen.

Dieselben Verhältnisse wurden auch in der Strassenluft constatiert, aber es zeigte sich hierbei die Luft im allgemeinen weniger rein als im Garten; ebenso wich bezüglich der Schimmelpilzarten die Gartenluft von der Strassenluft etwas ab.

3) Bei gleichen meteorologischen Verhältnissen sind die Monatsmittel der Schimmelpilzkeime von der Regenmenge abhängig.

4) Die Luft trägt bei starkem Winde eine reichliche Anzahl von Keimen in sich.

5) Gleich nach starkem Regen- und Schneefall war die Luft keimärmer an Schimmelpilzen.

6) Beinahe keimfreie Luft findet sich über dem Meere, während am Strande die Luft noch viele Keime enthielt. Es ist ohne weiteres klar, dass ein Luftraum über der Seefläche, wo die Schimmelpilzkeime ganz fehlen, in nicht allzuweiter Entfernung vom Strande gefunden werden dürfte.

7) Obgleich die Zahl unserer Versuche über den Keimgehalt der Laboratorium-, Hospital- und Kloakenluft noch recht gering ist, so ergibt sich doch, dass eine besondere Eigenthümlichkeit der Schimmelpilzkeime dieser Luft nicht existiert.


8) Die bei sämtlichen Versuchen am häufigsten gefundenen Schimmelpilze waren *Cladosporium herbarum*, *Penicillium glaucum* und *Epicoccum purpurascens*, danach *Aspergillus glaucus*, *A. nidulans*, *Catenularia fuliginosa*, *Mucor racemosus*, *Rhizopus nigricans*, *Macrosporium cladosporioides*, *Monilia* sp. und *Fyknidenbildner*.

9) Es ist als ein bezeichnender Charakterzug für die Ver-



breitung der Schimmelpilze in der Luft anzusehen, dass *Botrytis cinerea* und *Verticillium glaucum* nur in den wärmeren Perioden in der Gartenluft vorkamen, dagegen *Heterobotrys* sp. und *Fusarium roseum* besonders in kälteren Zeiten vorherrschten.

10) Selten wurden dagegen die folgenden Schimmelpilze aus der Luft isoliert:—*Mucor Mucedo*, *Chaetocladium Johnsi*, *Penicillium leucocephalum*, *Penicillium* sp., *Epicoccum nigrum*, *Alternaria tenuis*, *Aspergillus flavus*, *A. gigante-sulphureus*, *A. albus*, *A. caesiellus*, *Cephalothecium roseum*, *Oedocephalum crystallinum*, *Sepedonium chrysospermum*, *Glenospora* sp., *Verticillium tomentosulum*, *Sporotrichium laxum*, *Botryosporium pulchrum*, *Hyalopus ochraceus*, *Dematium pullans*, *Torula* sp., *Oospora* I, II und III, *Stysanus microsporus*, *Dendryphium penicilliatum*, *Dendryphium* sp., *Cylindrocephalum* sp., *Acremonium alternatum*, *Ovularia* sp., *Pestalozzia* sp. und *Verticicladium* sp.



### Anhang.

#### Systematische Anordnung der im Texte erwähnten Schimmelpilze.

##### I. Phycomycetes.

###### Gattung 1, Mucor.

*M. Mucedo* L. (Fig. 9)

*M. racemosus* Fres. (Fig. 7)

###### Gattung 2, Rhizopus.

*R. nigricans*. (Fig. 8)

###### Gattung 3, Chaetocladium.

*Ch. Johusii* Fres. (Fig. 27)

##### II. Ascomycetes.

###### Gattung 1, Aspergillus.

*A. glaucus* Link (Fig. 10)

*A. nidulans* Eidam (Fig. 11)

*A. flavus* Bref. (Fig. 13)

*A. albus* Willh. (Fig. 15)

*A. gigante-sulphureus* n. sp. (Fig. 12)

*A. caesiellus* n. sp. (Fig. 14)

###### Gattung 2, Penicillium.

*P. glaucum* Link. (Fig. 2)

*P. leucocephalum* Rabenh. (Fig. 35)

*P. sp.* (Fig. 32)

###### Gattung 3, Botrytis.

*B. cinerea* Pers. (Fig. 3)

##### III. Fungi imperfecti.

###### (1) Sphaelopsidales.

- Gattung 1,           ?  
                   Ein *Pyknidenbildner*.                   (Fig. 20)
- (2) Melanconiales.  
     Gattung 1, Pestalozzia.  
                   *P. sp.*                                   (Fig. 18)
- (3) Hyphomycetes.  
     Gruppe 1, Mucedinaceae.  
       Gattung 1, Oospora.  
                   *O. I.*                                   (Fig. 28)  
                   *O. II.*                                  (Fig. 37)  
                   *O. III.*                               (Fig. 44)  
       Gattung 2, Monilia.  
                   *M. sp.*                               (Fig. 23)  
       Gattung 3, Oedocephalum.  
                   *Oe. crystallinum* Ces.               (Fig. 29)  
       Gattung 4, Cyllindrocephalum.  
                   *Cy. sp.*                               (Fig. 31)  
       Gattung 5, Botryosporium.  
                   *B. pulchrum* Corda.               (Fig. 40)  
       Gattung 6, Hyalopus.  
                   *H. ochraceus* Corda.               (Fig. 19)  
       Gattung 7, Acremonium.  
                   *A. alternatum* Link.               (Fig. 36)  
       Gattung 8, Ovularia.  
                   *O. sp.*                               (Fig. 46)  
       Gattung 9, Sporotrichium.  
                   *S. laxum* Nees.                   (Fig. 38)  
       Gattung 10, Sepedonium.  
                   *S. chrysospermum* (Bull) Fr.       (Fig. 25)  
       Gattung 11, Verticillium.

- V. glaucum* Bon. (Fig. 6)
- V. tomentosulum* Speg. (Fig. 42)
- Gattung 12, Cephalothecium.
- C. roseum* Corda. (Fig. 26)
- Gruppe 2, Dematiaceae.
- Gattung 1, Torula.
- T.* sp. (Fig. 17)
- Gattung 2, Heterobotrys.
- H.* sp. (Fig. 22)
- Gattung 3, Glenospora.
- G.* sp. (Fig. 30)
- Gattung 4, Catenularia.
- C. fuliginea* n. sp. (Fig. 4)
- Gattung 5, Dematium.
- D. pullans* de Bary et Löw. (Fig. 39)
- Gattung 6, Verticicladium.
- V.* sp. (Fig. 43)
- Gattung 7, Cladosporium.
- C. herbarum* (Pers) Link. (Fig. 1)
- Gattung 8, Macrosporium.
- M. cladosporioides* Desm. (Fig. 21)
- Gattung 9, Alternaria.
- A. tenuis* Nees. (Fig. 45)
- Gattung 10, Dendryphium.
- D. penicilliatum* (Corda) Fr. (Fig. 24)
- D.* sp. (Fig. 41)
- Gruppe 3, Stilbaceae.
- Gattung 1, Styxanus.
- S. microsporus* Sacc. (Fig. 34)
- Gruppe 4, Tuberculariaceae.

Gattung 1, *Fusarium*.

*F. roseum* Link. (Fig. 16)

Gattung 2, *Epicoccum*.

*E. purpurascens* Ehrenb. (Fig. 5)

*E. nigrum* Link. (Fig. 33)

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Botanisches Institut  
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zu Tokio.



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## KORRIGENDA.

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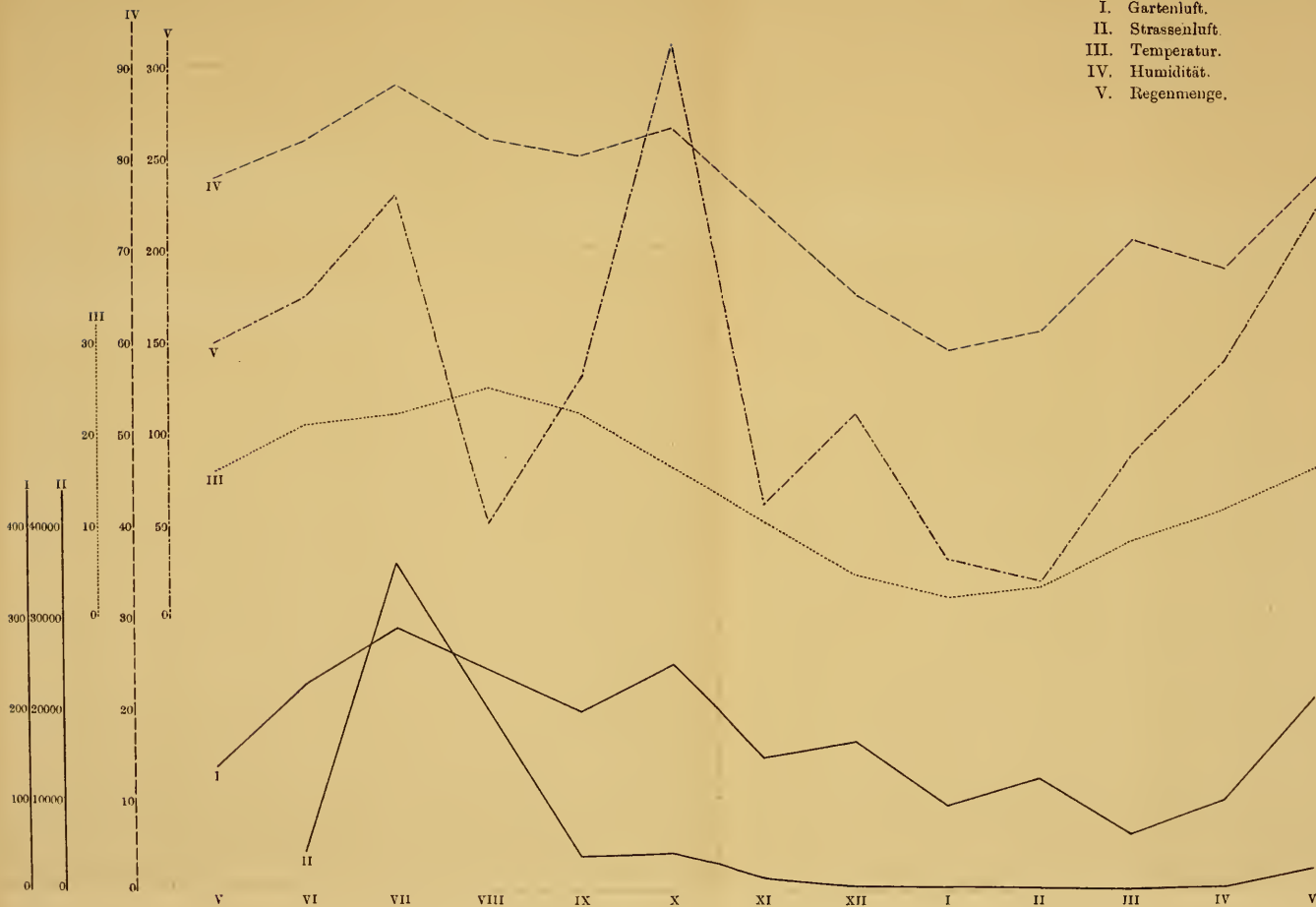
UNTERSUCHUNGEN UEBER DIE ATMOSPHAERISCHEN PILZKEIME.

TAFEL I.

## **Tafel I.**

**Tafel I** zeigt eine graphische Darstellung des monatlichen Keimgehalts der Schimmelpilze. Dabei stehen die Temperatur-, Humidität- und Regenmengekurven.

- I. Gartenluft.
- II. Strassenluft.
- III. Temperatur.
- IV. Humidität.
- V. Regenmenge.





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TAFEL II.

## Tafel II.

- Fig. 1. *Gadosporium herbarum*. *a* einfache, *b* verzweigte Conidienträger ( $\times 400$ ).
- Fig. 2. *Penicillium glaucum*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).
- Fig. 3. *Botrytis cinerea*. *a* Conidienträger mit Conidien, *b* Conidienträger, *c*, *d* Appressorien, *e* Conidien. *a*, *b*, *c*, *d* ( $\times 400$ ), *e* ( $\times 560$ ).
- Fig. 4. *Catenularia fuliginea*. *a* Kolonienform, *b* etwas vergrössert (schematisch), *c* Hyphen mit Conidien, *d* Keimung der Conidien. *c*, *d* ( $\times 560$ ).
- Fig. 5. *Epicoccum purpurascens*. *a* Conidienlager, *b* Conidienträger, *c* Hyphen kultiviert in Knop'scher Nährlösung mit Rohrzucker. *a* ( $\times 125$ ), *b*, *c* ( $\times 400$ ).
- Fig. 6. *Verticillium glaucum*. *a* Conidienträger, *b* Ende des Conidienträgers, *c* Conidien, *d* Gemmen in untergetauchten Hyphen. *a*, *d* ( $\times 400$ ), *b*, *c* ( $\times 560$ ).
- Fig. 7. *Macor racemosus*. *a* Natürliche Grösse, *b* Conidienträger, *c* Sporangium, *d* Sporen, *e* Gemmen, *f* Hefesprossung, *g* Zygosporien. *b* ( $\times 125$ ) *c* ( $\times 400$ ), *d*, *f* ( $\times 560$ ), *e*, *g* ( $\times 125$ ).
- Fig. 8. *Rhizopus nigricans*. *a* Natürliche Grösse, *b* Sporangiumträger, *c* Sporangium, *d* Columella, *e* Sporen. *b* ( $\times 125$ ), *c*, *d* ( $\times 400$ ), *e* ( $\times 560$ ).
- Fig. 9. *Macor Mucedo*. *a* Natürliche Grösse, *b* sterile Hyphe, *c* Sporangium, *d* Sporen. *b*, *c* ( $\times 400$ ), *d* ( $\times 560$ ).







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TAFEL III.

### Tafel III.

- Fig. 10. *Aspergillus glaucus*. *a* Conidienträger, *b, c* derselbe im jungen Stadium, *d* verzweigte Conidienträger, *e* anormale Form des Conidienträgers, *f* Conidien. *a, b, c, d, e* ( $\times 400$ ), *f* ( $\times 560$ ).
- Fig. 11. *Aspergillus nidulans*. *a* Normale Conidienträger, *b* zwergige Conidienträger, *c* anormale Conidienträger, *d, e* junge Stadien der Blase, *f* Conidien, *g* junger Fruchtkörper, in den weiten Mantel seiner Blasenhülle central eingelagert, *h* Membranverdickung der blasig geschwollenen Hyphenzweige, *i* reife Asks sporen. *a* ( $\times 500$ ), *b, c, d, e, h* ( $\times 400$ ), *f, i* ( $\times 560$ ), *g* ( $\times 125$ ).
- Fig. 12. *Aspergillus giganto-sulphureus*. *a* Conidienträger, einfache und verzweigte, *b* derselbe vergrößert, *c* anormale Conidienträger, *d* warzige Conidien. *a* ( $\times 125$ ), *b, c* ( $\times 400$ ), *d* ( $\times 560$ ).
- Fig. 13. *Aspergillus flavus*. *a* Conidienträger, *b* derselbe im jungen Stadium, *c* Conidien. *a, b* ( $\times 400$ ), *c* ( $\times 560$ ).
- Fig. 14. *Aspergillus caesiellus*. *a* Conidienträger, *b* derselbe im jungen Stadium, *c* glatte Conidien. *a, b* ( $\times 400$ ), *c* ( $\times 560$ ).
- Fig. 15. *Aspergillus albus*. *a* Conidienträger, *b* anormale Formen des Conidienträgers, *c* Conidien. *a, b* ( $\times 400$ ), *c* ( $\times 560$ ).
- Fig. 16. *Fusarium roseum*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).
- Fig. 17. *Torula* sp. *a* Conidienketten ( $\times 400$ ), *b* Conidien ( $\times 560$ ).
- Fig. 18. *Pestalozzia* sp. Conidien allein ( $\times 400$ ).
- Fig. 19. *Hyalopus ochraceus*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).
- Fig. 20. *Pyknidenbildner*. *a* Natürliche Grösse, *b* reife Pyknid, welche nach Anfeuchtung mit Wasser ihre Conidienmassen entleert, *c* das Anfangsstadium der Knotenbildung an einem Fadenstücke. *b, c* ( $\times 400$ ).







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TAFEL IV.

#### Tafel IV.

- Fig. 21. *Macrosporium cladosporioides*. Conidienträger mit Conidien ( $\times 400$ ).
- Fig. 22. *Heterobötrys* sp. *a*, *b* Mikroconidienträger mit Conidien, *c* Makroconidien in Ketten, *d* Keimung der Mikroconidien *e* Keimung der Makroconidien. Alles Fig. ( $\times 560$ ).
- Fig. 23. *Monilia* sp. ( $\times 400$ ).
- Fig. 24. *Dendryphium penicilliatum*. Conidienträger mit Conidien ( $\times 400$ ).
- Fig. 25. *Sepedonium chrysospermum*. Conidienträger mit Conidien ( $\times 400$ ).
- Fig. 26. *Cephalothecium roseum*. Conidienträger mit Conidien ( $\times 400$ ).
- Fig. 27. *Chaetocladium Johnsii*. *a* Conidienträger, *b* derselbe vergrößert, *c* Conidien. *a* ( $\times 125$ ), *b* ( $\times 400$ ), *c* ( $\times 560$ ).
- Fig. 28. *Oospora* 1. *a* Hyphen mit Conidien, *b* Conidien. *a*, *b* ( $\times 400$ ).
- Fig. 29. *Oedocephalum crystallinum*. *a* Conidienträger, *b* derselbe im jungen Stadium. *a*, *b* ( $\times 400$ ).
- Fig. 30. *Glenospora* sp. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).
- Fig. 31. *Cylindrocephalum* sp. Conidienträger mit Conidien ( $\times 400$ ).





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TAFEL V.

## Tafel V.

- Fig. 32. *Penicillium* sp. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).  
Fig. 33. *Epicoccum nigrum*. Conidien ( $\times 560$ ).  
Fig. 34. *Stysanus microsporus*. Coremium. einfach und in Bündeln ( $\times 400$ ).  
Fig. 35. *Penicillium leucocephalum*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).  
Fig. 36. *Acremonium alternatum*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).  
Fig. 37. *Oospora* II. ( $\times 400$ ).  
Fig. 38. *Sporotrichium laxum*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).  
Fig. 39. *Dematium pullans* ( $\times 400$ ).  
Fig. 40. *Botryosporium pulchrum*. *a*, *b* Conidienträger ( $\times 400$ ), *c* Conidien ( $\times 560$ ).  
Fig. 41. *Dendryphium* sp. *a* Conidienträger, *b* Conidien. *a*, *b* ( $\times 400$ ).  
Fig. 42. *Verticillium tomentosulum*. *a* Conidienträger ( $\times 400$ ), *b* Conidien ( $\times 560$ ).  
Fig. 43. *Verticicladium* sp. Conidienträger ( $\times 400$ ).  
Fig. 44. *Oospora* III. ( $\times 400$ ).  
Fig. 45. *Alternaria tenuis*. Conidienträger mit Conidien ( $\times 400$ ).  
Fig. 46. *Ocularia* sp. Conidienträger mit Conidien ( $\times 400$ ).







## On Some Jurassic Fossils from Rikuzen.

By

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*With 2 plates.*

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About the year 1885, Mr. I. BAN, then geologist to the Imperial Geological Survey, found a *Trigonia* belonging to the Group of *Undulatæ* at Hosoura, Rikuzen, a place adjacent to Isadomaye, a well known locality of *Pseudomonotis ochotica* KEYS. of the Upper Triassic. This gave the first hint of the occurrence of Jurassic formation in that part of Japan.

Subsequently in the years 1887 and 1888, Professor JIMBO made a geological investigation, not only of the district above mentioned, but also of the adjoining region and fully established the occurrence of Jurassic deposits by the side of the Triassic.

The present paper is an attempt to determine the age of the respective strata of the Jurassic by data furnished by the study of their fossils, collected partly by Professor JIMBO and partly by Mr. IKI who, in 1895, made a special research in the district around Hosoura. The fossils, although few in number and mostly of ill preservation, are still characteristic enough to give a tolerably clear idea of the geological horizons of the various layers containing them.

Professor JIMBO in his "Report of the Geological Researches of Eastern Rikuzen" (MS) mentions six horizons or beds as constituting the Jurassic of that region, which counted from below are as follows:

I. *Cyrena bed of Magenosu and Nirano-hama*, a dark clayslate filled with *Cyrena*.

II. *Karakuwa Clayslate*, with Gastropods, Lamellibranchs and Crinoids.

III. *Irinosawa Clayslate* with *Estheria*-like shells.

IV. *Trigonia Bed*, consisting of a hard, light-grey, medium-grained sandstone filled with shells of *Trigonia V-costata* LYCETT.

V. *Sandy Clayslate*, with *Arietites* and *Belemnites*.

VI. *Clayslate*, with Ammonites.

Of these six beds, he considers the first three as the lower, and the other three as the upper part of the formation separated by a line of unconformability.

The subdivisions subsequently proposed by Iki are similar to the above, although not quite the same.

The fossils described below are those obtained in the beds I., IV., V., and VI. They are the following:

From Bed I.

1. *Cyrena lunulata* n. sp.
2. *Cyrena oblonga* n. sp.
3. *Trigonia hosourensis* n. sp.
4. *Perna rikuzenica* n. sp.
5. *Gervillia trigona* n. sp.
6. *Baiera*? sp.

From Bed IV.

1. *Trigonia V-costata* LYCETT.

2. *Belemnopsis* sp.
3. *Belemnopsis* sp.
4. *Belemnites* sp.

From Bed V.

1. *Ammonites* sp.
2. *Ammonites* sp.
3. *Belemnites* sp.

From Bed VI.

1. *Harpoceras Ikianum* n. sp.
2. *Schlotheimia Jimboi* n. sp.
3. *Lytoceras* cf. *lineatum* SCHLOTH.

Judging from these fossils, there is not the least doubt about Bed VI being of a Liassic age. It is of course not possible at present to determine exactly to what part of the Lias it belongs. But as *Schlotheimia* is a genus hitherto confined to the Lower Lias and *Lytoceras lineatum* is a species only found in the Middle Lias, so it is most probable that the bed represents the lower half of the Lias, and it is also not altogether impossible that it is again divisible into two parts, the lower or *Schlotheimia*-bearing bed and the upper or *Lytoceras*-bearing bed.

Bed V is also probably Liassic, as the two *Ammonites* contained in it look very much like those of *Arietinæ*. By Professor JIMBO they have even been taken for *Arietites*. If such be really the case, then the bed must be assigned to the Upper Lias.

Bed IV is a very important one, as it contains *Trigonia V-costata* LXCETT, a species hitherto found only in the Inferior Oolite of England. And as a *Belemnopsis* which occurs together with it has never been found outside of the Dogger, so we may fairly assume that the bed represents the lower half of the Dogger, roughly corresponding to the Inferior Oolite of England.

The fossils found in Bed I are all new. But the resemblance of *Perna* to *Perna rugosa* of the Dogger and the occurrence of a *costated Trigonina* which has its greatest development in the same formation and of the genus *Cyrena* which is abundant in the Middle Jurassic plant-bearing series of other parts of Japan tend to show that the bed is still Middle Jurassic, possibly belonging to its upper part.

Beds II. and III., although their palaeontological characters are not yet known, must be considered as belonging also to the Dogger, as they lie between I. and IV.

From what has been said above, it is quite clear that the strata are inverted, Bed VI. which Professor JIMBO considered as uppermost being the lowest, and Bed I which was taken by him as the lowest being uppermost. According to my opinion, the so-called line of unconformability between III. and IV. may possibly be a line of fault.

## DESCRIPTIONS OF THE SPECIES.

### A. Fossils from Bed VI.

#### 1. *SCHLOTHEIMIA JIMBOI* N. SP.

Pl. I, Fig. 6.

The form which I designate under the above name is a discoidal shell somewhat distorted by pressure. Its diameter measures about 34 mm, while that of the umbilicus is about 6 mm, so that the shell may be said to be tolerably widely umbilicated. The lateral sides of the whorls are only slightly convex and ornamented with somewhat flexuous ribs which number 38-40



on the last whorl. Most of these ribs rise at the edge of the steep, almost perpendicular umbilicus, but there are some which commence either at a short distance from the edge or, as is sometimes the case, near the middle of the lateral side. The longest of these ribs are at first directed slightly forward and then curve somewhat backward, and then again forward on the external side, where they are interrupted by a deep narrow groove, an unmistakable sign of the genus *Schlotheimia*.

Our only specimen being not in a good state of preservation does not permit its strict comparison with European species. But that it is not *Schlotheimia angulata* to which it presents some resemblance is clearly shown by the different course of the ribs.

The genus *Schlotheimia* is confined in Europe to the lower Lias.

Locality :—Sandy Clayslate of Hosoura.

## 2. HARPOCERAS IKIANUM N. SP.

Pl. I., Fig. 5.

The shell flattened and furnished with a distinct keel. The whorls are tolerably convex and about  $\frac{2}{3}$  involute. The umbilicus is small being only 6 mm. in a shell whose diameter measures 20 mm. The umbilical wall is steep. The lateral sides of the whorls bear distinct ribs which are about 40 in number on the last volution. Of these 40 ribs, only about one half rise at the umbilical edge, the others being formed by their bifurcation at about  $\frac{1}{3}$  the distance from the umbilicus. But now and then between the bifurcating ribs there is intercalated a simple rib which does not reach the umbilicus. The course of the ribs may

be called weakly falcate, as they curve a little backward after bifurcation and then bend strongly forward near the external keel.

This form closely resembles the Middle Liassic species *Harpoceras lythense* YOUNG, but it is at once distinguished from it by its bifurcating ribs, in which respect it is not unlike some of the many varieties of *Harpoceras aalense* ZIETEN.

A single cast of an external surface of the shell was obtained in a sandy clayslate of Hosoura, our figure having been drawn from a plaster cast of it.

### 3. **LYTOCERAS** CF. **LINEATUM** SCHLOTH.

Pl. II. Fig. 5.

An external impression of a *Lytoceras* found in a clayslate of Aratohama, though water-worn and imperfect, shows characters so peculiar to the group of *Lytoceras fimbriatum* Sow. of the Liás, that I do not hesitate to bring it under that group, and indeed very near to *Lytoceras lineatum* SCHLOTH. The last volution of the shell measuring about 70 mm. in diameter is provided with many fine ribs which at certain intervals are coarser and decidedly fimbriate. The fimbriation of the ribs becomes more frequent as we approach the shell-mouth near which almost every rib is fimbriate. The non-fimbriate ribs are very fine, thread-like, more or less straight, and in some cases showing a tendency to fimbriation.

Besides those above mentioned, there is a single wall-like elevated rib near the middle of the last half of the last whorl.

Although our specimen lacks the outer portion of the whorl near the mouth, yet the characters given above agree so well with those of *Lytoceras lineatum* that it must be at least closely allied to, if not quite identical with, this European species.

*Lytoceras lineatum* SCHLOTH. occurs in the Middle Lias of England and Germany.

Our figure was drawn from a plaster-cast.

## B. Fossils from Bed V.

### 1. AMMONITES SP.

Pl. II. Fig. 11.

This is an external impression of a flat discoidal shell, about 45 mm. in diameter with a wide umbilicus of about 20 mm, and furnished with coarse, forwardly bent ribs about 33 in number in the last whorl. It closely resembles some of the forms of *Arietinæ*.

Locality :—Hosoura. The figure was drawn from a plaster-cast.

### 2. AMMONITES SP.

Pl. II. Fig. 10.

Another impression of a discoidal, widely umbilicated shell, about 35 mm. in diameter, which may be more or less closely allied to the preceding form, but its ribs (36 in number) are finer, more rigid and sharper.

The figure was drawn from a plaster-cast.

Locality :—Hosoura.

3. **BELEMNITES** SP.

Pl. II. Fig. 12.

A single specimen. It is provided with a part of the phragmocone and is lanceolate in shape, measuring about 37 mm. in length, and about 7 mm. in breadth near the upper end, reminding one of *Belemnites acutus* MILLER of the Lias. However the preservation is such that a strict specific determination is at present impossible.

Locality :—Hosoura, in a sandy clayslate.

## C. Fossils from Bed IV.

1. **TRIGONIA V-COSTATA** LYCETT.

Pl. II. Figs. 2, 3, 4.

LYCETT. *A Monograph of the British Fossil Trigonæ*,  
p. 66, pl. XIII, fig. 5, pl. XVI, fig. 1-4.

A *Trigonia* belonging to the group of Undulatæ and present in numerous specimens coincides so well in its characters with the species above named from England that I have not the slightest doubt about the identity of the two forms. The most important character of the species lies in the formation of a V-shaped angle by the meeting of the subtuberculated antea and postea ribs near the carina. This angle which is particularly distinct near the ventral margin of the shell gradually passes into a curve towards the beak.

Most of our specimens are small, being about the size of those figured as smaller ones by LYCETT. Fig. 4 shows the inner

side of a right valve on which is seen a rounded ridge on the posterior margin just below the upper edge and parallel to it.

The species occurs in England in the Inferior Oolite.

Locality :—Hosoura and Niranohama, in a greyish sandstone.

## 2. **BELEMNOPSIS** SP.

Pl. II. Fig. 1.

There are several specimens of a lanceolate Belemnite, one of which is about 35 mm. long and 8 mm. broad near its upper end. They all show a deep ventral groove running down to the apex. Therefore, although much water-worn, it is quite certain that they belong to the subgenus *Belemnopsis*.

Locality :—Hosoura.

## 3. **BELEMNOPSIS** SP.

Pl. II. Fig. 6.

A specimen of another form of Belemnopsis, the lower end of which is not preserved, is much larger than that of the preceding one. It seems to be broadest a little below the alveole where it measures about 12 mm. in diameter, thence slightly tapering upward.

Locality :—Hosoura.

## 4. **BELEMNITES** SP.

Pl. I. Fig. 7.

This fragment of a large Belemnite more than 20 mm. in

diameter has the lower end of the phragmocone intact. The transverse section of the rostrum is slightly oblong.

Locality :—Hosoura.

#### D. Fossils from Bed I.

##### 1. **BAIERA?** sp.

Pl. I. Fig. 2.

This is a fan-shaped leaf wanting the upper end, but looking very much like the basal portion of either a *Baiera* or a *Phœnicopsis*. Fine, longitudinal, simple veins constitute all that can be observed in the leaf.

Locality :—Hosoura.

##### 2. **CYRENA LUNULATA** n. sp.

Pl. II. Fig. 9.

Shell moderately thick, ovately triangular, slightly inequilateral, subrostrated both in front and behind, with curved ventral margin. Beaks prominent, touching, and directed forward. Surface with fine but unequal concentric striæ. In front of the beak is an ovate lunula about twice as long as broad and bounded by a fine deep groove running from the beak to the anterior margin. Behind the beak there is a sharp keel running to the posterior margin and enclosing a lanceolate valley-like area. Proportions of length to height and thickness are as 10 to 8 to 4.

The figured specimen measures about 25 mm. long, 20 mm. high and 11 mm. thick, and may be taken as representing the average size of the shell.

Locality :—Hosoura. Very numerous.



3. **CYRENA ELLIPTICA** N. SP.

Pl. I. Fig. 4.

Shell elliptical, broader than high, somewhat inequilateral, with anterior and posterior margin rounded and ventral margin curved. Beaks submedian, prominent, touching. Surface only with fine concentric striations. Proportions of length, height and thickness, 10 : 8 : 4.

This form is a little larger than the preceding one, and seems to have been comparatively thin shelled. There are specimens larger than the one figured.

Locality :—Hosoura. Rarer than the foregoing species.

4. **TRIGONIA HOSOURENSIS** N. SP.

Pl. I. Fig. 3.

A few specimens of a *Trigonia* belonging to the Group of *Costatæ* were obtained from the *Cyrena* slate of Hosoura which, though imperfect, show sufficient characters to be created into a new species.

The shell is ovately triangular, flattened and strongly inequilateral. The anterior side is very short with its border rounded. The posterior side is long and produced. Beaks prominent, and recurvate. The surface is ornamented with about 17 smooth concentric ribs which near the marginal carina descend with a very steep slope so that the curvature is stronger than in any of the known species of this group. Escutcheon narrow and lanceolate. Area depressed, and smooth.

The group of *Trigonia costata* has occurred hitherto only in the Oolite.

5. **GERVILLIA TRIGONA** N. SP.

Pl. II, Fig. 7, 8.

The shell is triangular, inflated and smooth. The beaks are prominent, close to the anterior extremity of the straight hinge-line, in which there are four ligamental pits, three of which are just below the beak, while the remaining one is situated a little behind it. They are separated from one another by nearly equal distances, although differing in shape the two middle ones being longitudinally elongated, the posterior transversely elongated, and the anterior obliquely elongated, the upper end being away from the others. The hinge line is anteriorly eared and posteriorly produced forming a large wing pointed at the end. The posterior border is nearly vertical and slightly concave below the hinge-border, while the anterior border which is also somewhat excavated in the middle recedes obliquely to a short rounded ventral border, so that the shape of the shell is decidedly triangular.

The proportions of the various dimensions of the shell are best seen in a cast drawn in fig. 7, in which the length of the hinge border measures 28 mm., the height of the shell 25 mm. and the thickness of the left valve 10 mm. The specimen shown in fig. 8 is more than double the size of the above, but it looks broader than it actually is, as it has been distorted by pressure.

The posterior wing of this species reminds one of the genus *Pteroperma* occurring in the Lower Oolite of France and England.

Locality :—Hosoura. Tolerably frequent.

6. **PERNA RIKUZENICA** N. SP.

Pl. I. Fig. 1.

Several specimens of a large quadrate *Perna* were obtained, which are however more or less broken. The figured specimen has both valves preserved and measures 8 cm. long, 6 cm. broad and 3 cm. thick. The shape of the shell, which is decidedly four-sided and has the anterior border concave resembles that of *Perna rugosa* GOLDF. figured by MORRIS and LYCETT in their *Monograph of the Mollusca of the Great Oolite* (pl. XII., fig. 1; pl. XIV., fig. 16). But on a closer examination our shell differs in several points from the European. In the first place our shell is a little more inflated; in the second place the greatest inflation lies very close the anterior border, so that the surface descends abruptly to it, while towards the posterior border the slope is very gradual; and in the third place the surface is not rugose, being marked only by fine concentric lines of growth.

Locality :—Hosoura.





M. YOROYAMA.

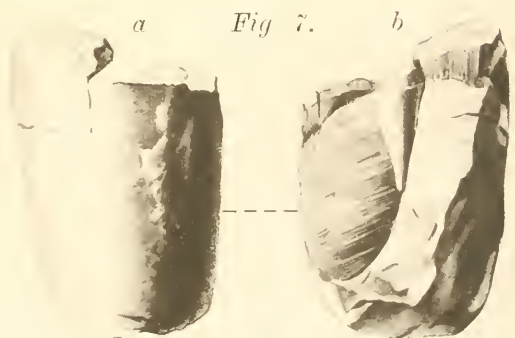
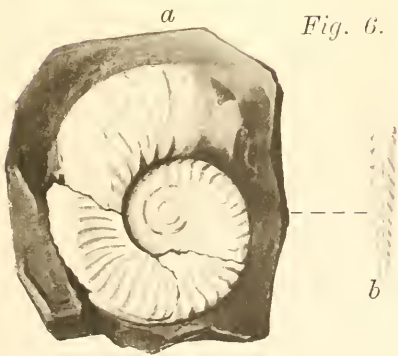
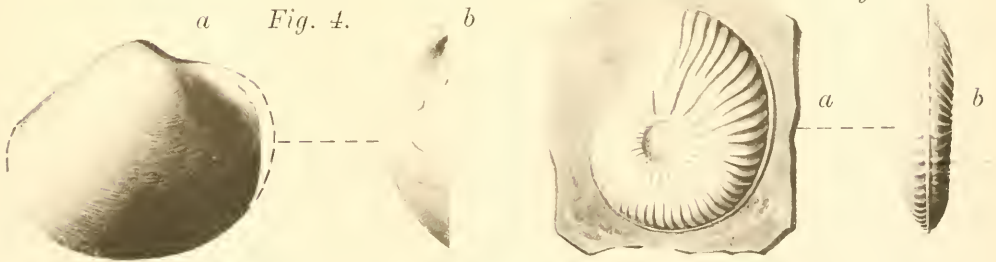
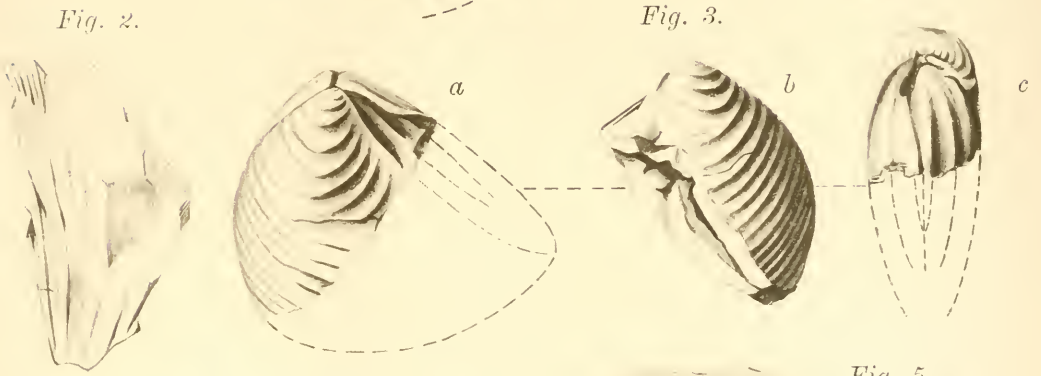
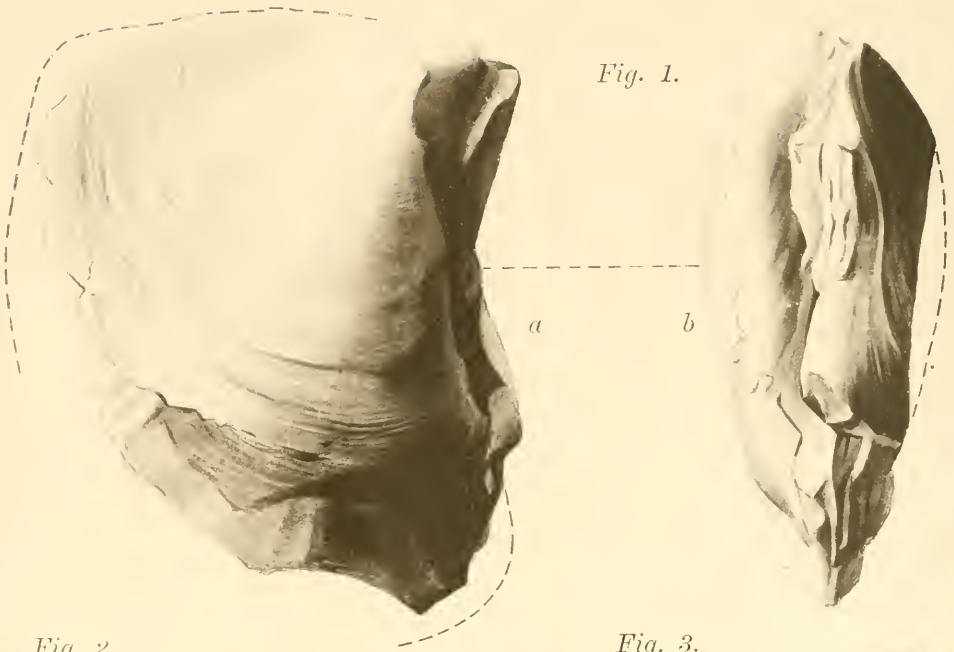
ON SOME JURASSIC FOSSILS FROM RIKUZEN.

PLATE I.

## Plate I.

- Fig. 1. *Perna rikuzenica* n. sp. *a* lateral view of a right valve; *b* front view of both valves.
- Fig. 2. *Baiera*? sp.
- Fig. 3. *Trigonia hosourensis* n. sp. *a* Left valve; *b* right valve, *c* showing area and escutcheon.
- Fig. 4. *Cyrena elliptica* n. sp. *a* right valve; *b* front view of the same.
- Fig. 5. *Harpoceras Ikianum* n. sp. *a* lateral view; *b* view of the external side.
- Fig. 6. *Schlotheimia Jimboi* n. sp. *a* lateral view; *b* showing the groove of the external side which is narrowed by pressure.
- Fig. 7. *Belemnites* sp. *a* and *b* seen from opposite sides, *b* showing a part of the phragmocone.







M. YOKOYAMA.

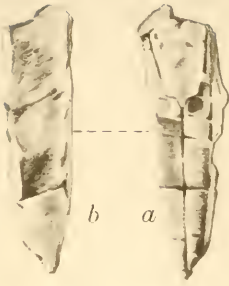
ON SOME JURASSIC FOSSILS FROM RIKUZEN.

PLATE II.

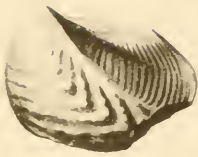
## Plate II.

- Fig. 1. *Belemnopsis* sp. A water-worn specimen; *a* showing the ventral groove and alveole; *b* the same seen from the opposite side.
- Fig. 2, 3, 4. *Trigonia V-costata* LYCETT. 2 left valve. 3 right valve. 4 inner side of a right valve.
- Fig. 5. *Lytoeceras* cf. *lineatum* SCHLOTH.
- Fig. 6. *Belemnopsis* sp. *a* showing the ventral groove and alveole; *b* the same seen from the opposite side.
- Fig. 7, 8. *Gervilla trigona* n. sp. Fig. 7, internal cast.
- Fig. 9. *Cyrea lunulata* n. sp. *a* lateral view; *b* seen from front; *c* showing lunula and area.
- Fig. 10. *Ammonites* sp.
- Fig. 11. *Ammonites* sp.
- Fig. 12. *Belemnites* sp.

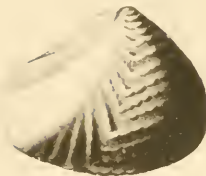
*Fig. 1.*



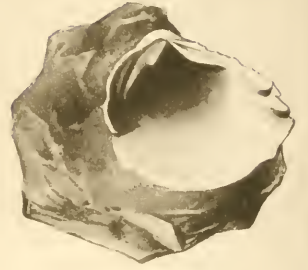
*Fig. 2.*



*Fig. 3.*



*Fig. 4.*



*Fig. 12.*



*Fig. 6.*



*Fig. 7.*



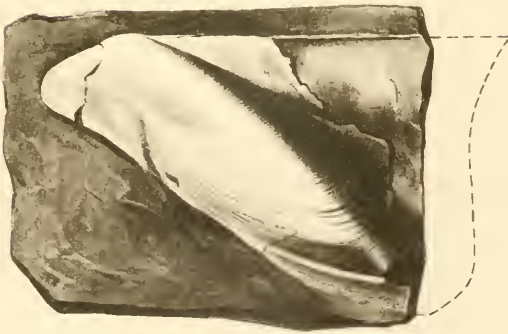
*Fig. 5.*



*Fig. 11.*



*Fig. 8.*



*b*



*Fig. 10.*



*Fig. 9.*







## Studies on the Hexactinellida.

### CONTRIBUTION IV.

(*Rossellidae*).

By

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*With 23 plates.*

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The Rossellidæ I define as follows :

Lyssacine Hexasterophora of cup-like or sacciform body; sometimes stalked; generally firmly attached at base and exceptionally rooted by basal processes or by tufts of basal spicules. Besides the main terminal osculum, a few secondarily formed oscula may occur. Ectosomal skeleton composed of small rough dermalia with a variable number of rays and of large hypodermalia. The latter are generally pentaactins which often show a tendency to protrude outwards in such a way that the paratangentials form a veil-like covering over the dermal surface. The dermalia, when hexactinic, have the distal ray not pinular but much like the rest in appearance. The gastralialia are generally rough

hexactins; without pentactins as hypogastralia. The hexasters are various but mainly oxyhexasters and discohexasters, these generally occurring together; but sometimes one kind occurs to the exclusion of the other. Oxyhexasters are often hemihexactinose and hexactinose. Discohexasters may be modified into discoctasters.

In the above, I have slightly modified the diagnosis of the same family as given in my Contrib. III., p. 114.

In '97 F. E. SCHULZE distinguished three subfamilies under the Rossellidæ, *viz.*, the Rossellinæ, the Lanuginellinæ and the Acanthascinae. To these I added in '98 a fourth under the name Leucopsacinae; but since I have later (Contrib. III.) given to this group the status of a distinct family, there remain F. E. SCHULZE's three subfamilies above-mentioned to make up the Rossellidæ. As was pointed out by that writer, they may be distinguished from one another by the absence or presence of strobiloplumicomes or of discoctasters, thus:

*a.*—Without discoctaster.

*a*<sup>1</sup>.—With strobiloplumicome.....A. *Lanuginellinæ*.

*b*<sup>1</sup>.—Without strobiloplumicome.....B. *Rossellinæ*.

*b.*—With discoctaster; no strobiloplumicome.....C. *Acanthascinae*.

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## A. LANUGINELLINÆ.

Pentactinic hypodermalia always present. Gastralia, hexactins. Parenchymalia consist of diactins and of large or medium-sized hexactins. Strobiloplumicome always present among the hexasters, which

for the rest consist of either discohexasters or oxyhexasters, or of both; without the discoctaster.

*Differential Key to the Known Genera and Species.*

- a.*—Firmly attached at base to solid substratum.
- a*<sup>1</sup>.—Without tufts of prostral diactins. Dermalia stauractinic. Only discohexasters present besides strobiloplumicomes.....
- .....1. *Lanuginella pupa* O. SCHM. (N. Atlantic; Polynesia; Sagami Sea).
- b*<sup>1</sup>.—With tufts of prostral diactins. Dermalia pentactinic and hexactinic. Only oxyhexasters present besides strobiloplumicomes.....
- .....2. *Calycosoma validum* F. E. SCH.\* (SE. of Mass.).
- b.*—Rooted in loose bottom by tufts of pentactinic anchor-needles.
- c*<sup>1</sup>.—Both oxyhexasters and discohexasters present besides plumicomes. Shaft of anchor-needles barbed in the distal part. Body-surface veiled.....
- .....3. *Mellonympa velata* (W. THOMS). (Strait of Gibraltar).
- d*<sup>1</sup>.—Only oxyhexasters present besides plumicomes. Shaft of anchor-needles smooth. Body-surface not veiled, but with tufts of long prostral needles.....*Lophocalyx*.
- a*<sup>2</sup>.—Body cup-like. Dermalia stauractinic. Oxyhexasters normal, with terminals shorter than principals.....
- .....4. *Lophocalyx philippinensis* (J. E. GRAY). (Philippines; Polynesia).
- b*<sup>2</sup>.—Body irregularly shaped. Dermalia, convex stauractins and pentactins; the latter having the unpaired ray directed distad. Oxyhexasters normal, hemihexactinose and hexactinose; terminals about as long as principals.....
- .....5. *Lophocalyx spinosa* F. E. SCH. (W. of Andaman Is.).

Of the above-mentioned four genera and five species referable to the subfamily, *Lanuginella pupa* is the only form that has as yet been discovered in the Japanese seas. A description of it after my own studies follows.

**LANUGINELLA PUPA O. SCHM.**

Contrib. III., Pl. V., figs. 1—7; and this Contrib., Pl. I.

O. SCHMIDT, '70, p. 13; Pl. II., figs. 1,3.—S. KENT, '70, p. 247; Pl. LXV., figs. 1-6.—F. E. SCHULZE, '86.

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\* For the grounds of placing here this genus and species, originally described by F. E. SCH. ('99) as an Asconematid, see my Contrib. III., pp. 73-83.

p. 47.—F. E. SCHULZE, '87 (!)\*, p. 130; Pl. LIII.,  
figs. 3-5.—F. E. SCHULZE., '97 (!), p. 548.—E. TOPSENT,  
'95, p. 213.—I. IJIMA, '98, p. 44.

The species has long been known from St. Jago, one of the Cape Verde Islands (O. SCHM.), from the coasts of Spain and Portugal (S. KENT,) from the Strait of Gibraltar (924 m.; TOPS.) and from off Little Ki Island (236 m.; "Chall.'). It occurs also in the Sagami Sea, so that it seems to be a very widely distributed species.

In the Sagami Sea, in all nearly a score or more specimens have thus far been obtained at Dōketsba, Mochiyama, Inside and Outside Okinosé and at a spot off the east coast of Vries Island. The depths from which they were obtained were 183-572 m. (100-313 fms.). The species is known to occur there along with *Euplectella marshalli*, *Leucopsacus orthodocus*, *L. scoliodocus*, *Staurocalyptus pleorhaphides*, *Crateromorpha meyeri*, *Hyalonema affine*, *Semperella stomata*, *Farrea* sp., *Hexactinella lorica*, etc.

The species is always firmly attached at base to the substratum. I have seen it growing on pebbles and shells as well as on dead remains of a coral, of a Bryozoa, of a Lithistid, of a *Farrea* and very frequently on *Hexactinella lorica*.

In the Challenger Report (p. 131), F. E. SCHULZE mentioned that the sponge might sometimes be rooted in a soft bottom by means of long anchors; this mention, so far as it goes, was probably founded upon observations, not on the present species, but on young *Lophocalyx philippinensis*, specimens of which, as we are told by him, were contained in the same bottle together

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\* In the list of literature given for each species treated of in this Contribution, the principal or the more important work or works are indicated by an exclamation mark in parenthesis.

with the *Lanuginella pupa* examined by him. In fact, a case of one and the same Hexactinellid species being firmly fixed when growing on hard substratum but producing a root-tuft when living on a soft bottom has never as yet been shown to exist.

The general shape of the sponge is ovoid or spherical, usually contracted below into a short stalk-like base. The body in larger specimens is often laterally compressed to a perceptible degree. Its small size led CARTER ('73 *a*, p. 283; '73 *b*, p. 359) to suspect that the species was based on young specimens of a larger sponge. It seems the species never attains a large size,—a size larger than, say, a large acorn or a hazelnut. One of the largest specimens I have measured was ovoid in shape, measuring 19 mm. in height and 11 mm. by 14 mm. in breadth at the broadest part. It had at the upper end a roundish osculum, 3 mm. in diameter. Wall as thick as  $4\frac{1}{2}$  mm. in the middle of the body. Another large specimen, likewise ovoid in shape, measured 22 mm. in length.

The specimen shown in natural size in fig. 1, Pl. I., measures 16 mm. in height and 13 mm. by 9 mm. in greatest breadth. The osculum, 3 mm. in diameter. Thickness of wall, as much as 4 mm.—The specimens of figs. 2 and 3 measure respectively 17 mm. and 10 mm. in height.

The osculum situated at or near the upper pole is always comparatively small; it is roundish or oval and has a thin smooth edge, never supplied with marginal prostals. It leads into a gastral cavity which is either pit-like or but slightly expanded internally, on account of the considerable thickness of the body-wall in the middle.—F. E. SCHULZE found small young specimens of 2–3 mm. diameter with the osculum still unopened. That negative condition may sometimes, but certainly does not always,

persist even when the sponge has attained the size of a pea or of a bean. This is attested by two specimens of the size indicated, which I have found in my collection. In both the sponge-wall is simply thinned out, without being broken through, at the point where one would expect the formation of the oscular aperture. Though I have not examined them on sections, I believe that the wall there lacks the chamber-layer as represented by F. E. SCHULZE in his fig. 5, Pl. LIII. (*l. c.*), and further that, in the absence of a single large aperture, the discharge of water from the gastral cavity must have taken place through the intertrabecular gaps of that part of the wall. All the rest of my specimens, including the smallest of 6 or 7 mm. height, show an open osculum.

In some specimens I have seen the external surface covered partly or nearly all over with a veil, formed of small hypodermal pentactins which had protruded through the dermal layer. So, for instance, in two of the specimens figured on Pl. I. All the smaller specimens are without the veil. Not that all the larger specimens are provided with it; on the contrary, the two largest specimens, respectively 19 mm. and 22 mm. high, seem to show no trace of it. Presumably it is formed only under certain circumstances after the sponge has reached maturity. In forming it, the hypodermal pentactins stand out isolatedly but usually at such intervals that their paratangentials are nearly or quite in touch with one another. Their shafts are exposed over the dermal surface to a length of  $\frac{1}{2}$ —1 mm.

The real dermal surface is smooth. When dried it is somewhat shiny, which is however by no means a peculiarity of the genus or of the species. The reflection of light takes place principally, if not solely, from the smooth hardened surface of



the dermal membrane. Seen under the hand-lens, the delicate dermal latticework contains minute meshes which are more or less regularly rectangular in shape, though in certain individuals I have found them irregularly shaped throughout nearly the entire extent of the layer. With the larger-meshed hypodermal lattice, it is quite usual that the intersecting of the thin laths takes place in an irregular manner; only seldom are the meshes of a rectangular shape. Generally speaking, the ectosomal skeleton seems to lie in tolerably close apposition to the choanosomal mass, so that the subdermal space is but inconspicuously developed. The entrances into incurrent canals, indistinctly visible from the outside, are small; the larger of them are separated from one another by a comparatively wide interspace.

Towards the stalk-like base of the sponge the hypodermal lattice becomes unnoticeable. It is here replaced by parenchymal bundles running in the main longitudinally and with these the ectosomal layer is apparently in direct contact.

The gastral cavity, instead of being lined with a continuous gastral or endosomal layer, shows the apertures of excurrent canals freely open. Many of the apertures are much larger than those of the incurrent canals in the same specimen. They may measure 2mm. across in fully grown specimens.

### Spiculation.\*

The *parenchymalia* consist of oxyhexactins and oxydiactins. In both these forms the rays run out to a sharp point and are either smooth all over or show a roughness near the end.

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\* I am indebted to Professor F. E. SCHULZE for a slide-preparation of *Lanuginella pupa*,—presumably of one from the Challenger collection. It has been useful for the purpose of comparison.

The oxyhexactins are numerous represented in the parenchyma and play an important part in the formation of the supporting skeleton. Though somewhat variable in size, most of them are of moderately large dimensions. They may be so large as to present an axial length of nearly 2mm., the thickness of rays reaching up to  $30\mu$  near the central node. All the six rays are not always of the same length. As a general rule, the spicules lie with one of the axes directed radially and are met with in a layer,—at places in a few irregular layers,—in the thickness of the choanosome.

The oxydiactins likewise occur in considerable numbers. They are here decidedly more numerous than in *Leucopsacus*, but not so numerous as in the generality of Rossellid members in which diactins form the predominant, if not the only, megascleric elements of the parenchymalia. In the present species, the spicules in question are mostly thin and small, not exceeding  $22\mu$  in thickness near the center, which may or may not be externally marked by an annular swelling. Some are seen to run in company with the radial rays of parenchymal oxyhexactins or of hypodermal pentactins; but the majority seem to pursue a more or less paratangentially directed course, either isolatedly or arranged in bundles, which are strongest in the stalk-like basal region of the sponge. Here a diactin may reach a length of 3 or 4mm.

Close to the attachment-surface there occur a number of stout-rayed and prickly-surfaced hexactins of about  $100\mu$  axial length, forming a thin layer. The same spicules are occasionally pentactinic and even stauractinic. There can be no doubt that we have here to do with the *basidictyonalia*. Some of the spicules are loosely disposed; others, especially those in direct contact with the substratum, are joined together by synapticulae in an irregular

manner, forming a continuous basal plate in which the individual spicules can without difficulty be recognized in their proper forms.

The *hypodermalia* closely resemble the parenchymal oxyhexactins in character, except in being always devoid of a distal ray. The cruciate paratangentials, 1 mm. or over in axial length and up to  $34\mu$  in thickness near the center, are usually in a slightly convex plane in conformity with the curvature of the body-surface. They may exhibit a sparing quantity of obsolete microtubercles near the pointed end (Pl. I., fig. 6) or may be quite smooth throughout. The unpaired proximal ray, more generally smooth all over, is straight and may be nearly three times as long as the paratangential.

As before mentioned, the hypodermalia in certain specimens are protruded through the dermal layer, their paratangentials thus forming a veil over the external surface. In one such veiled specimen,—namely, the one depicted in Pl. I., fig. 1,—I have found most of the prostalia to be rough-surfaced on the paratangentials (Pl. I., fig. 7) as well as on the shaft, but the latter only for a short distance from the spicular center. This shagreen-like roughness, which is known to exist also on the same spicules of several other Rossellids, is due to minute, fine, erect and closely set processes. On the paratangentials, the processes are most pronouncedly developed on the outer surface; laterally they become obsolete, leaving the inner surface along the middle line nearly smooth. Not that all the prostal pentactins are shagreened in the manner described, for some are quite devoid of this characteristic. On the other hand, among the hypodermalia, *i. e.*, the prostalia before protrusion, there occasionally occur such

as show the same roughness of surface. It then seems that this shagreen-like character, beginning to arise, whenever it occurs, while the spicule is yet hypodermally situated, does not constitute a constant peculiarity of all old hypodermalia. This opinion is also supported by the fact that the specimen referred to is the only one in which I have seen the rough pentactins, while in all the rest I have failed to find the same spicules, whether as prostalia or as hypodermalia, characterized in the same way.

The *dermalia* (Pl. I., fig. 4) are rough stauractins, exceptionally and very rarely tauactins; they are nearly flat or perceptibly convex on the outer side. The rays taper but little towards the end which is rounded. The prickles on the surface are erect and generally tolerably conspicuous, but are subject to a considerable variation in this respect according to individuals, as are also the spicules in respect of their size. In most specimens the axial length averaged  $220\ \mu$  (the maximum being  $280\ \mu$ ) in length and  $7\ \mu$  in breadth near the central node. In one specimen, however, I found the average axial length to reach up to  $330\ \mu$  (the maximum being  $374\ \mu$ ); the rays tapering gradually towards the conically or obtusely pointed end and being beset with rather inconspicuous prickles. F. E. SCHULZE ('97) had given 160–200  $\mu$  as the size of the dermalia.—It is by no means rare to meet, here and there among the dermalia, with perfectly smooth, small and unusually thin-rayed oxystauractins, such as are shown in Pl. I., fig. 5. They are evidently dermalia in an incomplete stage of development.

The *gastralia* (Pl. I., fig. 8) are regularly shaped oxyhexactins, measuring 220–330  $\mu$  in axial length and  $7\frac{1}{2}\ \mu$  in average

breadth of rays near the central node. The surface is uneven on account of obsolete microtubercles. The freely projecting ray is in no way differently characterized from all the rest. The gastralia occur abundantly but do not form a continuous lattice-work. Oxyhexactins of precisely the same appearance also occur in scattered distribution along the inner surface of excurrent canals—especially of the larger excurrent canals—as the *canalaria*. (See fig. 9).

The *hexasters* consist of the discohexaster and the strobiloplumicome.

The *discohexaster* (Pl. I., figs. 11 and 12; also Contrib. III., Pl. V., figs. 1-6) occurs commonly throughout the entire sponge-wall. It shows considerable variations in both size and appearance in the same as well as in different specimens. In general it may be said to be spherical or approximately spherical, in that the terminals so diverge peripherally that all the terminal discs are situated nearly equidistant from one another. In general appearance it most closely resembles certain discohexasters of *Chaunoplectella* and of *Leucopsacus scoliodocus*. The diameter ranges from 40  $\mu$  to 90  $\mu$  (according to F. E. SCHULZE, 32-100  $\mu$ ). In some specimens of the species, however, the largest discohexaster does not exceed 70  $\mu$  in diameter. Aside from certain exceptional cases, each short or very short principal bears 2-4 or 5 (most commonly 3) terminals. The number may vary with different principals in one and the same rosette. The terminals appear to be rather strong—at any rate not quite thin except in the case of the smallest discohexaster; they are either of about the same thickness throughout the entire length or thicken slightly towards the outer end. Their surface, when

seen under a high magnifying power, is rough on account of microtubercles (Pl. I., fig. 12). In some cases, the roughness of the surface is more pronounced than in others, the microtubercles being then visible as minute reverted prickles or barbs. The convex terminal disc, when well developed as is generally the case, exhibits comparatively strong recurvate marginal prongs, 5-6 in number. Occasionally the prongs are minute or quite obsolete; they may even be apparently wanting, in which case the terminals appear as if ending bluntly, in all probability representing a developmental stage previous to the formation of the terminal prongs. In rare instance I have seen small and delicate oxyhexaster-like forms, which I consider to be likewise an early stage in the genesis of the discohexaster.

One individual (Mus. No. 436) of the species from Outside Okinosé, which I have studied with special thoroughness as regards the spiculation, requires to be here particularly mentioned. In it I have discovered, though certainly as rare abnormalities, cases of the discohexaster in which some—not all—of the terminals are bent outwards and backwards, directly after their origin from the principal, in a semicircle or in a comma-like manner, apparently with no definite rule as to the relative orientation of the plane of curvature. They are not unlike the peculiarly twisted oxyhexasters figured by F. E. SCHULZE from *Bathydorus spinosus* (Chall. Rep., Pl. LIX., fig. 9) and from *Rhabdocalyptus mollis* (*l. c.*, Pl. LXIV., figs. 10, 11).—As representatives of normal discohexasters in the same specimen I have shown three in my Contribution III., Pl. V., figs. 1-3. Some of the smallest, such as is shown in *l. c.* fig. 3, are distinguished by the fact that the number of terminals is somewhat more numerous than usual, there being six or more of them to each principal.



Such forms are nearly as delicate as the so-called microdiscohexasters of certain other Rossellids, but grade over by transitional forms into the larger and commoner varieties, such as are depicted in figs. 1 and 2 (*l. c.*). They evidently correspond to the small and inconspicuous rosettes which were mentioned by F. E. SCHULZE (Chall. Rep., p. 131) as having been observed by him in some, but not in all, of his specimens. I am likewise of the opinion that the form in question is an inconstant one, only exceptionally presented by the smaller discohexaster of the species. —Further I have to note that in the same specimen I have met with a few hexactinose discohexasters which are in no way distinguishable from the same of *Leucopsacus scoliodocus*. I believe they are simply extrinsic, and am confirmed in this opinion by the fact that the specimen had been kept in a bottle together with the Leucopsacid just mentioned.

The *strobiloplumicome* (Pl. I., fig. 13; also Contrib. III., Pl. V., fig. 7) of the well-known form seems to be constantly present in all individuals though in varying numbers. So sparse is it in some that it requires a special search in preparations in order to find one. In others it occurs in greater or less abundance, not confined to the subgastral region but appearing in the subdermal as well, though frequently more numerous in the former than in the latter. I have met with the rosettes in especial abundance in a large specimen of 19 mm. height, in which they occurred subdermally and subgastrally as well as in all parts of the choanosome.

In one specimen of the species, the rosettes in question measured in diameter 34–42  $\mu$ ; in another, 45–50  $\mu$ ; and in still another 50–76  $\mu$ .

Structurally and in appearance the rosette is quite similar to the same of *Sympagella* (Contrib. III., p. 106). The hemispherical knob, bearing the feather-duster-like bunch of delicate terminals, usually shows at the center of the convex outer surface a small process, into which the axial filament is seen to extend itself. The process then is a direct continuation of the principal and represents the outer end of the primary ray of a hexactin; the terminal-bearing knob and the terminals with it are then to be considered as secondary structures that have developed along the course of a primary ray, not at its outer end. This may be held as an indication that the strobiloplumicome is a hexaster *sui generis*, having arisen independently of the ordinary discohexaster and oxyhexaster in which the terminals appear to be *ab origine* at the very ends of primary hexactin-rays.

The central process above referred to may be more or less atrophied and may even disappear altogether. Thus, several instances in the present species have come under my observation in which the process was reduced to a mere acuminous point, the entire knob in shape presenting a resemblance to an acorn. In some other exceptional cases I have convinced myself, as I did also with some of the same rosettes in *Sympagella anomala*, that the central process was totally wanting.

### Soft Parts.

All that I have observed as regards the soft parts of this species may be referred to in brief.

In fig. 9, Pl. I., the soft parts are shown as seen in a section under a low power of the microscope. The shading given to the chambers is somewhat artificial. With respect to fig. 10, which is meant to illustrate the highly magnified appearance of

the chamber-wall as well as that of archæocytes and of trabeculae arising from the chamber-rim, I must state at once that it is to a great extent a failure, in part due to the unsuccessful lithographing and in part to the highly unsatisfactory state of the original preparation.\*

The chambers are shallow and cup-like or long and thimble-like or tubular. Their diameter, 77-132  $\mu$ ; on an average 100  $\mu$ . Length, up to 440  $\mu$ . The longest are found at the blind ends of excurrent canals, in the periphery of the choanosome: they may sometimes present a lobed or branched appearance. All the more deeply situated chambers are cup-like. In all my preparations, the chamber-wall appears at the best as a faintly stained reticulum with minute irregular meshes. The nuclei are not discernible under ordinary powers of the microscope; but by using an immersion system they can, under favorable circumstances, be recognized as ill-defined spots found at short intervals and measuring not more than 2  $\mu$  across. In staining capacity they differ scarcely at all from the substance of the reticulum. Flagella seem to be in no case preserved.

The trabeculae are developed in moderate, and in some individuals in very great, abundance. On the external sponge-surface they are frequently spread out in a film-like manner to form the perforated dermal membrane. The nuclei are minute but distinct, being well stained as usual. Not seldom have I seen, hanging on the trabeculae, homogeneous fat-like spherules which stained well with both carmine and hæmatoxylin: they were no doubt the product of the thesocytes.

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\* Many of the plates, now issued in this Contribution, were prepared and printed several years ago in the early period of my studies and therefore contain shortcomings of which I am more conscious than ever. For them I beg to ask a lenient judgment.

The archæocytes are as usual deeply stained and on the whole somewhat larger than trabecular nuclei. They do not exceed  $3\frac{1}{2} \mu$  in diameter. Though sometimes found isolated, they more commonly occur in loose or compact groups varying greatly in dimensions, always among, and on the outer side of, the chambers. Many of the groups are of a quite conspicuously large size (Pl. I., fig. 9).

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### B. ROSSELLINÆ.

Pentactinic hypodermalia generally present; exceptionally wanting. Gastralia, hexactins; exceptionally pentactins. Parenchymalia, chiefly diactins and including medium-sized or small hexactins, or exclusively diactins. Hexasters consist as a rule of oxyhexasters and discohexasters; the latter often in more than one variety, but may be totally absent: lacking both strobiloplumicome and discoctaster.

The following is a list of all the genera and species which I consider to make up the subfamily as it stands at present.

1. *Rossella antarctica* CARTER. (= *Acanthascus grossularia* F. E. SCH.). (S. of Kerguelen Is.; SE. of Prince Edwards Is.; Possession Is.; 256-549 m.).
2. *R. dubia* (F. E. SCH.). (S. of Puerto Bueno, 732 m.).
3. *R. racovitza* TOPS. (Western Antarctic, 450-569 m.).
4. *R. nuda* TOPS. (Western Antarctic, 430 m.).
5. *Scyphidium septentrionale* F. E. SCH. (N. of Spitzbergen, 1000 m.).

6. *S. longispina* (Ij.). (= *Rossella longispina* Ij.). (Sagami Sea).
7. *S. namiyei* (Ij.). (= *Vitrollula namiyei* Ij.). (Sagami Sea).
8. *S.* sp. (= *Rossella* sp. F. E. SCH. '99). (Messier Channel in S. Chile, 821 m.).
9. *Vitrollula fertilis* Ij. (Sagami Sea).
10. *Schaudinnia arctica* F. E. SCH. (N. of Spitzbergen, 1000 m.).
11. *Crateromorpha meyeri* J. E. GRAY. (Philippine Is., 174 m.; Sagami Sea).
- 11a. *C. meyeri tuberosa* Ij. (Sagami Sea).
- 11b. *C. meyeri rugosa* Ij. ( , , ).
12. *C. pachyactina* Ij. (Tosa Sea, Japan).
13. *C. corrugata* Ij. (Sagami Sea).
14. *C. thierfelderi* F. E. SCH. (= *C. murrayi* F. E. SCH.). (Little Ki Is., 236-256 m.).
15. *C. tumida* F. E. SCH. (Banda Is., 658 m.).
16. *Hyalascus*\* *sagamiensis* Ij. (Sagami Sea).
17. *H. similis* Ij. (Off coast of Prov. Tōtōmi, Japan).
18. *H. giganteus* Ij. (Sagami Sea).
19. *Aulochone cylindrica* F. E. SCH. (= *Crateromorpha cylindrica* (F. E. SCH.)). (Kermadec Is., 1097 m.).
20. *Aulochone lilium* F. E. SCH. (= *Crateromorpha lilium* (F. E. SCH.)). (Meangis Is., NE. of Celebes, 914 m.).
21. *Aulochone lankesteri* (R. KIRKP.). (= *Crateromorpha lankesteri* R. KIRKP.). (Off SE. coast of Cape Colony, 457-549 m.).

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\* For including in the Rossellinæ the genera *Hyalascus* and *Asconema*, placed by F. E. SCHULZE ('97) under the Asconematidæ, see Contrib. III., pp. 81, 82.—For the omission, in the list here given, of the three genera *Placoplegma*, *Aulocalyx* and *Euryplegma*, all referred to the Rossellinæ by F. E. SCHULZE (*l. c.*), see Contrib. III., pp. 29-32.

22. *Aulosaccus schulzei* IJ. (Sagami Sea).
23. *A. ijimai* (F. E. SCH.). (= *Calycosaccus ijimai* F. E. SCH.). (S. of Alaska, 291 m.).
24. *A. mitsukurii* IJ. (Sagami Sea).
25. *Asconema*\* *setubalense* S. KENT. (N. Atlantic, 185–1170 m.).
26. *Trichasterina borealis* F. E. SCH. (N. of Spitzbergen, 1000 m.).
27. *Aphorme horrida* F. E. SCH. (Off San Diego, Cal., 849 m.).
28. *Bathydorus fimbriatus* F. E. SCH. (N. Pacific, 4206 m.).
29. *B. stellatus* F. E. SCH. (Messier Channel, S. Chile, 256 m.).
30. *B. laevis* F. E. SCH. (B. of Bengal, 3652 m.).
31. *B. uncifer* F. E. SCH. (Galapagos Is., 717 m.).
32. *B. spinosus* F. E. SCH. (Penguin Is., 2926 m.).
33. *B. baculifer* F. E. SCH. (S. Mid-Pacific, 4270 m.).

### Differential Key to the Genera.

(The numbers in parenthesis refer to those of the above list).

*a.*—Without pentaactinic hypodermalia.

*a*<sup>1</sup>.—Body trumpet-like or with gastral surface everted so as to form a large part of the outer surface; always with long stalk. Discohexaster in one small variety, or entirely wanting.....*Autochone* F. E. SCH. (Nos. 19–21).

*b*<sup>1</sup>.—Body saccular or vase-like, without stalk. Discohexaster in two (large and small) varieties .....*Aulosaccus* IJ. (Nos. 22–24).

*b.*—With pentaactinic hypodermalia.

*c*<sup>1</sup>.—Hexaster consists of oxyhexaster only (without discohexaster).

*a*<sup>2</sup>.—Paratangentials of hypodermal pentaactin, spiny. All oxyhexasters hexactinose. ....*Aphorme* F. E. SCH. (No. 27).

*b*<sup>2</sup>.—Paratangentials of hypodermal pentaactin, not spiny but smooth and rough at ends only. Oxyhexasters, some or all normal.



- a*<sup>3</sup>.—Trichaster present besides ordinary oxyhexaster with larbed terminals.  
.....*Trichasterina* F. E. SCH. (No. 26).
- b*<sup>3</sup>.—Without trichaster. Oxyhexaster terminals rough or nearly smooth.....  
.....*Bathylorus* F. E. SCH. (Nos. 28-33).
- d*<sup>1</sup>.—Hexaster consists of oxyhexaster and discohexaster.
- c*<sup>2</sup>.—Dermalia, pentactins with the unpaired ray distally directed.....  
.....*Aseonema* S. KENT. (No. 25).
- d*<sup>2</sup>.—Dermalia variable; generally without distally directed ray, which, if present, as it sometimes is, invariably belongs to a hexaster and not to a pentactin.
- c*<sup>3</sup>.—Body smaller than acorn-size; parenchymalia include a considerable quantity of relatively large hexactins.....*Vitrollula* IJ. (No. 9.)
- d*<sup>3</sup>.—Body much larger; parenchymalia, diactins only or may include medium-sized or small hexactins.
- a*<sup>4</sup>.—Gastralia not hexactins, but pentactins or other forms without free proximal ray. Sponge with distinct stalk.....  
.....*Crateromorpha* F. E. SCH. (Nos. 11-15),
- b*<sup>4</sup>.—Gastralia, hexactins. Sponge generally without, but sometimes with stalk.
- a*<sup>5</sup>.—Pentactinic hypodermalia partly with spiny and partly with smooth paratangentials. Rooted in loose bottom by basal processes.....*Schaudinna* F. E. SCH. (No. 10).
- b*<sup>5</sup>.—All pentactinic hypodermalia with smooth paratangentials rough at ends only. Firmly attached at base.
- a*<sup>6</sup>.—Discohexaster in one small form of moderately uniform size  
.....*Hyalascus* IJ. (Nos. 16-18).
- b*<sup>6</sup>.—Discohexaster in more than one form and differing in size; at any rate, the smallest being of about half the diameter of the largest, or even much smaller.
- a*<sup>7</sup>.—Discohexaster distinguishable into three varieties, of which the largest has the terminals to each principal arranged in a narrow or a perianth-like tuft. Other varieties spherical.....*Rossella* CART. (Nos. 1-4).
- b*<sup>7</sup>.—Discohexasters all spherical, and without the largest form mentioned under *a*<sup>7</sup>.....  
.....*Scyphidium* F. E. SCH. (Nos. 5-8).

Further treatment is given, in this contribution, to only those genera and species known to me from Japanese waters.

**SCYPHIDIUM** F. E. SCH.

Saccular or vasiform, thick-walled, firmly attached by contracted base; showing a disposition to produce buds on the wall. Parenchymalia exclusively diactins. Pentactinic hypodermalia with paratropal or regularly cruciate, smooth or finely shagreen-like paratangentials, without spines. Dermalia, stauractins or pentactins, or both; rough-surfaced. Gastralial, regular hexactins with rough rays; forming a continuous layer over ex-current canalar apertures. Oxyhexaster normal, hemihexactinose or hexactinose. Discohexaster distinguishable into two forms differing in size, but both being spherical in shape. These two forms may grade over into each other; at all events, the smallest discohexaster is only about half as large as the largest or even much smaller.

The genus was first instituted by F. E. SCHULZE ('00) to receive the species *septentrionale* from the Arctic Ocean. Two forms occurring in the Sagami Sea and described by me before in brief under the names of *Rossella longispina* ('96) and *Vitrollula namiyei* ('98) I now consider to be generically unitable with *Scyphidium septentrionale* F. E. SCH. Further, the specimen from Messier Channel (Southern Chile), which had been described by F. E. SCHULZE ('99, p. 43) as *Rossella* sp. without receiving a specific name, likewise seems to be referable to the same genus and to represent a species especially closely related to my *Scyphidium namiyei*.

Under *Rossella* I put together the species (Nos. 1-4 of the

list) in which the hexaster consists of oxyhexasters and of discohexasters in three varieties differing in size and appearance (macrodiscohexaster, mesodiscohexaster and microdiscohexaster). Now, *Scyphidium* in the scope given it by me differs from that genus chiefly in the fact that the hexaster occurs in only two varieties, the macrodiscohexaster of *Rossella* being wanting here. However there can be no doubt of the especially close relationship existing between the two genera. As another very close ally of *Scyphidium* is certainly to be considered *Vitrollula fertilis* IJ., which however lacks not only the macrodiscohexaster but also the mesodiscohexaster seen in *Rossella*, the only discohexaster-form present being apparently the microdiscohexaster.

The chief differential characters of the species of *Scyphidium* may be seen from the following key.

*a.*—Dermalia, stauractins.

*a*<sup>1</sup>.—Pentactinic hypodermalia with smooth, regularly cruciate paratangentials. Larger discohexaster 80  $\mu$ , and microdiscohexaster 40  $\mu$  in dia. Oxyhexaster, about 100  $\mu$  in dia. Sponge with stalks; without prostalia.....  
.....*S. septentrionale* F. E. SCH. (N. of Spitzbergen).

*b*<sup>1</sup>.—Pentactinic hypodermalia with either paratropal or regularly cruciate paratangentials, which are either smooth or shagreen-like. Larger discohexaster 90–130  $\mu$ , and microdiscohexaster 24  $\mu$ , in dia. Oxyhexaster, 100–122  $\mu$  dia. Sponge with contracted base; with long and conspicuous diactinic prostalia, in addition to which pentactinic prostalia may occasionally occur.....  
.....*S. longispina* (IJ.). (Sagami Sea).

*b.*—Dermalia, pentactins and stauractins. Pentactinic hypodermalia with smooth regularly cruciate paratangentials. Sponge with thick stalk-like base.

*c*<sup>1</sup>.—Larger discohexaster of 100  $\mu$  dia. leading down to microdiscohexaster of 35  $\mu$  dia. Oxyhexaster, 53–76  $\mu$  in dia. Without prostalia.....  
.....*S. namiyei* (IJ.). (Sagami Sea).

*d*<sup>1</sup>.—Larger discohexaster of 100  $\mu$  dia. leading down to microdiscohexaster of 25  $\mu$  dia. Oxyhexaster in two varieties; the smaller and thinner-rayed, 80–100  $\mu$ ; and the larger, 120–150  $\mu$  in dia. Synapticular fusion among parenchymalia. Prostalia ?.....*S. sp.* (Messier Canal in Chile. Vide F. E. SCH. '99).

**SCYPHIDIUM LONGISPINA** (Ij.)

## Plate II.

*Rossella longispina*, IJIMA, '96, p. 253.

Two specimens are now before me. The type-specimen, which is the larger and on which my original description was based, comes from Yodomi in the Sagami Sea (depth, about 429 m.). The second specimen, obtained last year, is from Inside Okinosé (about 572 m.). In general appearance both are not unlike certain *Staurocalyptus* or *Rhabdocalyptus* with spiny prostal needles.

The type-specimen (Pl. II., fig. 1) represents a pear-shaped, laterally compressed, thick-walled sac narrowed below into a stalk-like base, where it is torn off. Length, 51 mm.; greatest breadth, 37 mm. Thickness of wall, in places 6 mm. The osculum at the top is oval, 14 mm. by 7.5 mm.; its edge, thin and simple. The external surface is uneven on account of low conical elevations, from the apex of which strong diactinic prostalia project in an obliquely upward direction, some to a length of 30 mm. or more. These prostal needles stand out sometimes singly, but more commonly two or more (up to about half a dozen) together in tufts. They may moreover be associated with a few small and inconspicuous pentactinic prostalia, which are far too sparse to form a veil. Between the apices of the elevations the dermal surface is quite smooth. (Pl. II., fig. 10).

Attached to the diactinic prostalia and apparently pierced right through by these, there are two small young individuals of the same species. Possibly they arose as buds, which, after separation from the mother-body, were shifted outwards along the prostalia, similarly as in *Lophocalyx philippinensis*. One of the

young individuals is 15 mm. long; it already shows a small oscular opening in its outer end. The other is much smaller, measuring only 6 mm. in length; the osculum is still unopen. Both possess thin and short prostal needles of their own.—Besides the young, a number of Foraminifera, some of which are about as large as a pin-head, are borne on the prostal needles of the old specimen.

The dermal skeleton is in close contact with the choanosome. The extremely delicate lacework formed by the dermalia exhibits meshes, more or less regularly quadrate, which are so small as to be scarcely discernible with the naked eye. The hypodermal latticework is formed of thin strands which intersect one another at various angles and thus produce irregularly shaped and rather small meshes. The larger incurrent canals visible through the dermal layer may be 2 mm. wide.

The simple gastral cavity is lined throughout with a smooth and continuous gastral layer. Under the lens this appears meshed like the dermal layer. Some apertures of excurrent canals situated right under it may be as wide as 3 mm.

The second smaller specimen (Mus. No. 507) from Inside Okinosé, is of an oblong ovoid shape. The lower end is likewise torn off. Length, 37 mm.; greatest breadth 18 mm.; osculum, 8 mm. by 9 mm. The lower half of the sponge presents a smooth undulating surface. The upper half bears a number of long and strong prostal needles; in this part the surface is much lacerated, to which fact may be due the fact that conical elevations are not observable in this specimen. On the prostals again are attached some Foraminifera, but no buds or young. The spiculation essentially agrees with that of the type-specimen.

### Spiculation.

The following description refers to the large type-specimen shown in Pl. I., unless the other is specified.

The *parenchymalia* are exclusively diactins, of which some may be distinguished by larger dimensions as the *principalia*.

The *principalia* are oxydiactins with smooth or but faintly roughened ends; generally bow-like and sometimes boomerang-like in shape. The length may reach 12 mm. or more and the thickness at the middle, 350  $\mu$ . The oxydiactinic *prostalia* are evidently nothing else than *principalia*, which in a certain position have grown excessively in length. A large prostal oxydiactin measured was 50 mm. long and 275  $\mu$  thick. Smaller *prostalia* gradually grade over into the intraparietal *principalia*.

Similarly, the latter intergrade with the finest (7  $\mu$  thick) *parenchymalia* occurring as *comitalia*. These and in fact all the more slender *parenchymalia* are of a nearly uniform thickness throughout their length and terminate with rough-surfaced, conically or obtusely pointed ends. Externally the spicular center is indicated not even by an annular swelling.

The thin strands constituting the irregularly meshed *hypodermal latticework* are made up for the greater part of diactins, exactly comparable in characters to those of similar dimensions in the parenchyma. One of them selected for the purpose of measuring was about 2 mm. long and 23  $\mu$  broad in the middle. Though occasionally found running singly, they are usually more or less combined into bundles of varying strength.



*Pentactinic hypodermalia* seem to be confined in their distribution to the upper part of the body. Here they are in places not uncommon, especially on the conical hillocks. I have been unable to detect any regularity in the mode of their relative arrangement. They are never very large; the largest I have picked out measured: length of paratangential ray, 1.5 mm.; that of the unpaired proximal ray, 5 mm.; thickness of rays near the center, 55  $\mu$ . But the majority are considerably smaller. The paratangential rays, which taper outwards to a sharp point, are either regularly cruciately or more or less paratropally disposed. The latter form arises as the result of some strong diactinic prosthelia in immediate proximity exercising a pressure in a lateral direction upon the paratangentials, pushing these away from them and thus widely opening one of the four angles which otherwise would all be right-angled. In some of the spicules, the rays are all perfectly smooth; in others, the paratangentials present a finely shagreen-like surface (Pl. II., fig. 3), caused by the same minute and thickly set processes which I have met with on certain hypodermalia of *Lanuginella pupa* (p. 9). The proximal ray, as also that part of the diactinic prosthelia which dips into the sponge-wall, is accompanied with comitalia of the usual appearance.

As before mentioned, isolated pentactinic hypodermalia may project outwards, generally in association with the diactinic prosthelia on or near the apex of the external hillocks (Pl. II., fig. 10). The pentactinic prosthelia, unlike the other kind, are quite inconspicuous.

As rare abnormalities of the hypodermalia under consideration, I may mention a case in which a distal sixth ray was present as a short rudiment, and another case in which two of

the paratangentials bore—one a single and the other three—prickles, suggestive of the same occurring in *Rossella antarctica*.

The *dermalia* (Pl. II., fig. 2) are stauractins, nearly flat or perceptibly concave on the inner side. The microtubercles, which beset the rays all over, are distinctly developed. The rays slightly taper outwards, to end in a rounded manner. Axial length, 250–360  $\mu$  (300  $\mu$  on an average); breadth of ray near the center, 7–12  $\mu$  (10  $\mu$  on an average). In forming the quadrate-meshed latticework, two rays of the directly adjoining dermalia run, as usual, alongside of each other for the greater part of their length. The meshes generally measure 140–180  $\mu$  in length of sides.—Exceptionally and quite rarely the dermalia are met with in the straight diactinic form. Of more frequent occurrence here and there are oxystauractinic forms with smooth and unusually thin rays. They are evidently dermalia that have not yet attained full development.

The dermalia of the second specimen from Inside Okinosé require special mention in that pentactinic forms were not seldom found amongst them.

The *gastralia* (Pl. II., fig. 4) are hexactins much larger than the dermalia, but with similarly characterized rays. Axial length, generally 0.55–1.00 mm. (0.75 on an average); breadth of ray close to base, 15–22  $\mu$ . The free proximal ray shows no point of special differentiation from the rest. Though the spicules are present in tolerable abundance, the paratangentials form but rarely meshes of approximately quadrate shape. The layer lies closely upon parenchymalia, of which none can however

be distinguished as hypogastralia. There exist no pentactins under the layer.

In the two large specimens in hand, both being torn off at base, the *basidictyonalia* can not be observed. I have therefore examined one of the two young individuals for those characteristically ankylosed spicules, and actually found them in the basal region of the little sponge growing on a prostal needle. This was at the place directly invested by a thin and small-meshed siliceous reticulum, the basal-plate of F. E. SCHULZE, over which was a layer of irregularly distributed hexactins, the basidictyonalia. These are small but thick-rayed, with uneven surface. They are in fusion not only with the basal-plate but also here and there with themselves, in a manner similar to the condition seen in fig. 12, Pl. XXI. The mode of their occurrence on a spicule of another individual reminds me of the small basidictyonal masses I have found in *Staurocalyptus glaber* (cfr. Contrib. I., p. 186, foot-note).

The *hexasters* are of the following three types :

1. *Oxyhexaster*. This occurs in great abundance in the choanosome as well as in the subdermal space. Especially numerous is it near the gastral surface and in the gastral layer itself. It is not uncommon to see several attached to the proximal ray of the gastralia, as if they had been shifted on from below along it. Diameter, 100-122  $\mu$ . The principals are always exceedingly short, so that the bases of terminals are situated close to the somewhat swollen central node. The terminals are obsoletely rough-surfaced. As to their number and the degree of their development, there exists a certain difference between the oxy-

hexasters in the periphery and those in the deep part of the wall.

The former, as for instance those situated in the subdermal space, are as a rule normally developed, showing generally 3, but sometimes 2 or 4, terminals to each principal. The terminals are thin, measuring only about  $2\ \mu$  in thickness at base.

The latter, as represented by those in the gastral layer, have perceptibly stronger terminals, about  $3\ \mu$  thick at base. Moreover they are but seldom normally developed, exhibiting 2 terminals to each principal. The majority are hemihexactinose, there being also found not uncommonly quite hexactinose forms (Pl. II., figs. 5, 6). Of the hemihexactinose forms, the total number of terminals to the entire rosette may vary between 7 and 11 (most frequently 9 or 10) indicating in each case the number of the principals which remain biterminal and of those which had become uniterminal. In some cases one of the two terminals borne on a principal was found to be very much shorter than the other, these shorter terminals representing without doubt intermediate stages in the transition from a biterminal principal into a uniterminal. In both the hemihexactinose and hexactinose forms, the uniterminal principal may show the well-known bending at the point of its junction with the single terminal remaining to it, the two parts being not straightened out as they quite frequently are.

2. *Discohexaster*. Much less numerous than the oxyhexasters are the discohexasters (Pl. II., fig. 7), which occur subdermally and somewhat less sparingly in the choanosome. In a few cases they were found together with oxyhexasters on the free proximal ray of gastralialia. Diameter, 90–130  $\mu$ . Each short principal, which is swollen knob-like at end, bears 4–6, long, slender, faintly rough-surfaced terminals diverging so as to give an approx-

imately spherical shape to the entire rosette. The convex terminal disc consists of 6, small, recurved teeth (fig. 8).

3. *Microdiscohexaster*. This (Pl. II., fig. 9) is clearly distinguished from the above by its small size and by the more numerous and exceedingly fine terminals. It is found in sparse distribution both subdermally and subgastrally. The shape is spherical with a diameter of only 23–25  $\mu$ . The terminal disc is so minute that it appears simply pinhead-like.

### Soft Parts.

As the type-specimen was thrown into alcohol at the place of capture, I was able to make some observations on the soft parts, which may be worth recording in brief. All my sections are stained with borax-carminé. Figs. 10 and 11, Pl. II., show the general appearance of the soft parts in section.

The dermal membrane is represented for the most part by a sparse quantity of quite thin trabeculae running between the rays of dermalia. It is membranously developed only here and there in limited areas between closely situated parts of certain dermalia.

The cup-like or thimble-like chambers measure 100  $\mu$  in average diameter. Examined under very strong magnification (Zeiss' homog. immers. system), its wall or the *membrana reticularis* exhibits *distinctly open* meshes. The delicate beams consist of granular protoplasm which is scarcely stained by the coloring reagent (Pl. II., fig. 14). Each nodal point, as seen surface on, is occupied by a faintly colored and clear looking nucleus, containing a few granules in its interior. Its boundary can not be said to be well defined but is often sufficiently indicated by the cyto-



plasmic granules lying against it as well as by the slight but perceptible difference in the staining capacity of the plasma within and without it. Diameter of the nucleus, not more than  $2\frac{1}{2}$   $\mu$ . Flagella, not observed.

Archæocytes occur either isolatedly or in small flat groups on the outside of the chamber-wall. Size,  $2\frac{1}{2}$ –4  $\mu$ ; exceptionally 5 or 6  $\mu$ . Here as in *Euplectella marshalli*, one is soon led to the conviction that he has before him small *cells*,—not nuclei,—unless an inadequate power of the microscope be used for the observation. At least the larger archæocytes are distinctly seen to be composed of deeply stained cytoplasm containing a still more deeply stained nucleus, which is indistinguishable from a trabecular nucleus both in size and appearance.

Sections of the large specimen are remarkably rich in peculiar bodies which I take to represent the thesocytes. We have here to do with clusters of fat-like globules found among the trabeculae of both the subdermal and subgastral regions. They are shown, not quite successfully, in Pl. II., fig. 12. The globule, when of large size, may measure 20  $\mu$  across. Its substance is nearly homogeneous and weakly refractive, taking the stain tolerably well. It may at times be of a conglomerate-like or of an irregularly granular appearance. Not infrequently a small nucleus is seen in direct contact with the surface; the appearance then being that the bodies in question are some unusually bulky cell contents or product which has pressed the nucleus of the turgid cell against the external limit.

Together with the above there occasionally occur smaller and more weakly stained spheres with granular contents. They are shown in both figs. 12 and 13, Pl. II., and will be easily recognized. In the case of these again I have frequently ascertained



that they contained a nucleus which was pressed against the wall. Cases also came under my observation, in which the spheres in question showed a close approach, in size as well as in the character of the contents, to the thesocytes which are filled up with the fat-like product. So that, I am inclined to think that they represent but an early stage in the development of thesocytes.

In sections of one (the larger) of the two young individuals found attached to the prostalia of the specimen, I find the thesocytes by no means so copiously present. On the other hand, I see in them an abundance of peculiar bodies, the like of which I have not met with in the large specimen and the nature of which remains perfectly dark to me. The bodies consist of numerous, thin, deeply stained filaments, which reach up to  $55\ \mu$  in length and are arranged either radially so as to present an irregularly star-like appearance or in brush-like bunches diverging from a point (Pl. II., fig., 15). The filaments are sometimes nearly straight and needle-like; sometimes gently bent or wavy. The general appearance reminds me of the groups of stearin and margarin crystals, which A. LETELLIER\* obtained from the alcoholic extract of the organ of Bojanus. But the stainability of the filaments at once excludes the idea of their being crystals. Possibly we have here to do with something which is certainly not identical with, but is allied to, the groups of rod-like bodies I have met with in *Acanthascus cactus* and *Euplectella marshalli* (Contrib. I., p. 180); at any rate, they all seem to be bodies foreign to the sponges.

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\* A. LETELLIER. Fonction urinaire chez les Mollusques acéphales.—Arch. Zool. Expér. T. V. 2me Serie, p. 48; Pl. I., figs. 6, 7.

**SCYPHIDIUM NAMIYEI (Ij.)**

Plate VI., figs. 9-17.

*Vitrollula namiyei*, IJIMA, '98, p. 48.

Two complete specimens and some fragments of this species were obtained by KUMA in one haul of the long-line at Outside Okinosé by the Iwado-line, from a depth of about 457 m. (250 faths.).

Both complete specimens (Pl. VI., fig. 9) present a laterally compressed, irregularly shaped, moderately thick-walled, pouch-like body of a moderate size. Above, there exists in both a secondarily formed osculum besides the primary. Below, the somewhat contracted base had evidently been firmly fixed to the substratum by an irregular attachment surface or rather by a number of such.

The larger specimen (Pl. VI., fig. 9*a*) is 66 mm. high. A cross-section of the laterally compressed body at its widest part would present an oblong outline, 54 mm. long and about half as broad. The wall is about 5 mm. thick in the middle of the body. The upper end is occupied by a large, irregularly oval, sharp-edged osculum. To one side of this and well apart from it on the sagittal edge of the body, there is a papilla-like bud, the rounded apex of which shows a secondary osculum of 2 mm. diameter. This leads into a small gastral cavity about 5 mm. deep, which does not stand in open communication with the principal gastral cavity. The specimen also shows on one side an oval-shaped gap in the wall, leading into the main gastral cavity.

The smaller specimen (fig. 9*b*) is 56 mm. high. It is widest at the upper end, measuring 41 mm. in the longest direction

whereas, from side to side in the middle of the compressed body, it measures not more than 20 mm. across. Two separate oscula of different sizes, lying side by side, occupy the upper edge of the body. There is a clear indication of the two having been formed from an originally single and narrow osculum by the coming together and fusion of the oscular lips at one part, in a way similar to the process which takes place at the bifurcating point of a *Farrea*-tube. The smaller of the oscula thus formed occupies the end of a short tube which appears like a branch from the sponge-body.

In both specimens, there are present along the sharp oscular edge some prostal needles, which are fine, short and quite inconspicuous, besides being irregularly distributed and isolated. Similar prostals also occur in quite small numbers in the upper part of the lateral wall. They are in all cases diactins projecting to the extent of 3 or 4 mm. at most.—In places there are to be seen some isolated hypodermal pentaactins apparently more or less protruded beyond the dermal level. Whether this represents a normal state or is the result of rough handling, I am at loss to decide.

On the whole the external surface may be said to be smooth. To the naked eye it appears as if loosely frosted. Not until observed under the hand-lens can the dermal latticework and the hypodermal supports be seen with distinctness. The dermal layer is in very close contact with the choanosome.—The subdermally situated entrances into the incurrent canals are small, probably never more than  $1\frac{1}{2}$  mm. in width.

The gastral surface is likewise smooth. It is continuously covered throughout by a most delicate gastral layer, supported on fine sinuous hypogastral strands.—The excurrent canalar apertures,

indistinctly visible through the gastral layer, may be 2 mm. wide.

In the wet state the sponge-wall is rather firm but can be easily torn off. When dried it is of a light, delicate and friable texture.

### Spiculation.

The *parenchymalia* consist of diactins only,—oxydiactins as a rule. These comprise all sizes from the large, elongate-spindle shaped or bow-like principalia down to the shorter and very much thinner comitalia. They are somewhat closely felted together in forming the parenchymal mass. (See Pl. VI., fig. 17).

The principalia, which occur rather numerously, may attain a length of 10 mm. and a thickness of 120  $\mu$  in the middle. They are smooth all over, even near the sharply pointed ends. The smaller parenchymalia, leading down to comitalia of only 10  $\mu$  thickness, often show an indication of an annular swelling at the center and are sparingly beset with obsolete microtubercles at the ends, which taper to a point instead of being slightly swollen as usual.—Certain small diactins on the outer and inner surfaces of the choanosome are formed into thin strands and go into the support of the dermal and gastral layers, more especially of the latter.

*Hypodermal oxypentactins* are abundantly present. The rays are all smooth throughout and always regularly cruciate in disposition. They are never very large, the paratangential axial length not exceeding 3 mm. The unpaired proximal ray is usually more than three times as long as the paratangential in the same spicule. Breadth of rays at base, as much as 55  $\mu$ .—No pentactins occur as hypogastralia.

Irregularly meshed *basidictyonalia* of the usual appearance are found in a thin connected layer over the places of basal attachment. The beams, which may be  $20\ \mu$  thick, are uneven-surfaced with scattered spiny processes.

The *dermalia* (Pl. VI., fig. 10) are spinose stauractins and pentactins of considerable strength. As to the relative quantity of these, the former somewhat predominate over the latter in some places, and *vice versa* in certain other places. The rays are  $90\text{--}165\ \mu$  long (as measured from the center), all those in one and the same spicule being nearly equally long. They are thick (up to  $20\ \mu$  at base) and taper gradually outwards to the conically or bluntly pointed end. The microspines are well developed. The paratangentials are in a plane scarcely or but slightly concave on the inner side. In the case of pentactinic dermalia, the unpaired ray is always directed proximad.

The *gastralia* (Pl. VI., fig. 11) are hexactins and pentactins; exceptionally stauractins. The hexactins seem to be numerically the predominant form, though in some places the pentactins (with the unpaired ray directed distad) are found in about as great abundance. In the dimensions of rays and in the nature of their microspines, the gastralia are quite like the dermalia. The proximal free ray presents no features of special development.

The *oxyhecasters* (Pl. VI., fig. 12) occur in very great abundance throughout the choanosome. There is no appreciable difference in appearance between those situated in the subdermal and in the subgastral region. They are of a rather small size, measuring  $53\text{--}76\ \mu$  in diameter. Nearly all are normally devel-

oped, each short principal bearing 2–4 terminals. Only occasionally do hemihexactinose forms occur, especially in the middle of the choanosome. The terminals are only moderately strong; their surface is rough. The minute processes causing this roughness, when examined under a strong power of the microscope, are seen to be distinctly inwardly directed (fig. 13).

The *discohexasters* (Pl. VI., figs. 15 and 16), present likewise everywhere in the choanosome, are less abundant than the above, though in several parts of the subdermal and subgastral regions they are found lying numerously together side by side. They are mostly of about the same size as the oxyhexasters or of a larger size, reaching up to 100  $\mu$  in diameter. Others are so small as to measure only 35  $\mu$  in diameter; discohexasters of such small size may be taken as representing the microdiscohexaster of the species. However, it is important to mention that the larger discohexaster (fig. 16) and the microdiscohexaster (fig. 15) in the present species are much the same in general appearance and are besides gradationally linked together by intermediate sizes. So that, it is also not improper to say that discohexasters are present in only one form, which is quite variable as to size (35–100  $\mu$  dia.), the smallest being less than half the size of the largest as measured by the diameter. Much the same relation seems to obtain among the corresponding rosettes (25–100  $\mu$  dia.) of *Scyphidium* sp. (= *Rossella* sp. F. E. SCH. '99, p. 43) described by F. E. SCHULZE from the coast of Chile; whereas, in *S. septentrionale* and *S. longispina* the microdiscohexaster is clearly distinguished from the larger discohexaster-form not only by its smaller size but also by having the terminals in far greater abundance.—In the present species it may be said in



general that the discohexasters, irrespective of size, have 3-5 (or occasionally more), slender and faintly rough-surfaced terminals to each very short principal. All the terminals so radiate from the ends of principals that a spherical shape is given to the entire spicule. The arched terminal disc is composed of 5-8, distinctly developed, recurved prongs.

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### VITROLLULA L.

In '98 I included two species under this genus; but since I now consider that one of them had better be referred to *Scyphidium* and have described it above as *S. namiyei*, there remains only *V. fertilis* to represent the genus. A generic diagnosis may therefore be dispensed with.

The genus and species is a small-bodied sponge, which would be difficult to distinguish from a *Lanuginella* or a *Leucopsacus* without a microscopic examination of the spiculation. This closely resembles that of *Scyphidium*, of *Crateromorpha* and of *Hyalascus*. It differs from that of the first mentioned genus mainly in that the parenchymalia include hexactins and in that discohexasters occur in a single form which apparently corresponds to the microdiscohexaster. In these respects the agreement with certain *Crateromorpha* may be said to be almost complete, but the conspicuous difference with respect to the size and shape of the body may be regarded as sufficient to warrant the generic distinction. The difference from *Hyalascus* consists again in the much smaller size and further in the presence of hexactinic parenchymalia, in the oxyhexasters being pertinently normally developed, &c.

**VITROLLULA FERTILIS** IJ.

Plate III.

*Vitrollula fertilis*, IJIMA, '98.

Four specimens in all of this genus and species have been at my disposal for study. I regard it worth while to mention the following particulars about each of them.

Two specimens, forming Sc. Coll. Mus. Sp. No. 228, were found attached in the dried state to a *Lophohelia*-like coral, obtained by KUMA April 2nd, 1894, at Okinosé from a depth estimated at about 429 m. (235 fms.). Both are of about the same shape, being spindle-like, slightly bent and broader at the oscular than at the somewhat contracted basal end. One of them is shown in Pl. III, fig. 1. It is 15 mm. long and 6 mm. broad in the middle, where the body is approximately circular in cross-section and the wall measures  $1\frac{1}{2}$ – $1\frac{3}{4}$  mm. in thickness. The small, thin-edged osculum at the superior end has a diameter of  $1\frac{1}{4}$  mm. The other individual of the lot is slightly larger, being 16 mm. long and 7 mm. broad in the broadest part.

The third specimen (Sci. Coll. Mus. Sp. No. 231), shown in Pl. III, fig. 2, was obtained by myself July 23rd, 1894, at a spot about 4 kilometers off the village of Inatori on the eastern coast of the Province of Izu. The depth was somewhere between 330 m. and 414 m. (180–228 fms.); the bottom consisted of sand, pebbles and shells. There it occurred together with *Parrea*, *Aphrocallistes*, *Hyalonema affine* var. and *Semperella stomata*, specimens of all of these having been secured at the same time. The body of the specimen in question is laterally compressed; it is 12 mm. high and  $8\frac{1}{2}$  mm. by 5 mm. broad. Wall, 2 mm.

thick in the middle of the body. The circular osculum at the upper end measures 3 mm. in diameter. The contracted and laterally compressed base is attached to a horny worm-tube.

The fourth specimen (Sci. Coll. Mus. Sp. No. 433) was obtained by KUMA in November, 1895, from an unknown depth at Inside Okinosé. In shape it is ovoid and slightly laterally compressed. It is torn off at the narrower end. Length, 14 mm.; breadth,  $7\frac{1}{2}$  mm. Wall, about 2 mm. thick. The oval osculum at the broader end measures  $2\frac{1}{2}$  mm. by  $1\frac{1}{2}$  mm. in diameter.

All the specimens agree in having a smooth external surface. Through the dermal layer, which is in close contact with the choanosome, are seen the variously sized, but generally small, apertures to incurrent canals; they rarely exceed  $\frac{3}{4}$  mm. in width. The gastral surface presents a somewhat honeycombed appearance owing to the fact that excurrent canals open freely into the gastral cavity, the apertures being not covered over by a continuous gastral layer (Pl. III., figs. 7 and 8). Some of these apertures may be  $1\frac{1}{2}$  mm. wide. The gastral cavity is deep. The body-wall gradually thins out towards the thin simple oscular edge.

The texture of the sponge is delicate, soft and light. The basal end, for a greater or less extent, is firm, which is due to the basidictyonal mass being developed to a not inconsiderable thickness.

### Spiculation.

The *parenchymalia* consist of slender diactins and more or less regular hexactins.

The former are present in tolerable abundance, running

either isolatedly or in weak bundles. They are all thin and filamentous, probably never attaining a thickness of more than  $12\ \mu$ . The majority, if not all, of them have the spicular center externally indicated by an annular swelling or by four cruciately disposed knobs. The rays are smooth except at the roughened ends, which sometimes terminate conically and at other times taper out to a point. Scarcely any of the diactins can be distinguished as principalia.

The latter are by no means uncommon, though they are more plentiful in some individuals than in others. They sometimes appear to be comparatively strong. Thus, a large parenchymal hexactin may measure 1.6 mm. in axial length, the rays being  $30\ \mu$  thick at base. However, the majority of the hexactins are considerably smaller and weaker. The rays gradually taper outwards and are smooth all over except near the conically pointed end. As a general rule the hexactins are so disposed that one of the axes is radially directed, without however showing much regularity in the arrangement. Sometimes their rays are seen to pursue a solitary course; more frequently are they joined with the diactins in small numbers to constitute the parenchymal strands.

As in so many other lyssacine Hexactinellids, the basal end of the sponge exhibits a typical *basidictyonal* mass (Pl. III., fig. 22). This consists of a rigid, irregularly meshed reticulum of comparatively thick beams, the surface of which is beset throughout with small tubercles. These beams, for the most part, may without difficulty be recognized as the rays of unusually stout hexactins, which are ankylosed either directly ray to ray or by means of synapticular formations. The synapticulæ on the surface

of the mass in contact with the substratum form a thin close-meshed limiting layer (see the lower part of fig. 22).

The *hypodermalia* (Pl. III., fig. 3) are moderately large pentactins; their rays closely resemble in character those of parenchymal hexactins. The regularly cruciate paratangentials may measure 1 mm. in axial length and  $27\ \mu$  in breadth near the spicular center. The proximal fifth ray is always longer than the paratangential in the same spicule and at times is nearly twice as long. In the smaller hypodermalia the size of the paratangential cross approaches or may even nearly coincide with that of the larger stauractinic dermalia, so that in certain cases it is scarcely possible to decide whether a pentactin is to be considered as a dermalia or a hypodermalia. This may perhaps be regarded as an indication of the low degree of differentiation of the species from the Leucopsacidæ. Seen on surface-view preparations, the paratangential crosses are situated for the most part without any regularity of mutual arrangement, though at places they may show an attempt, so to speak, at the formation of a quadrate-meshed latticework. The hypodermalia are never observed protruded as prostalia; nor are they ever found with shagreen-like surface.

The *dermalia* are stauractins, the plane of which is usually slightly convex on the outer side. The rays are relatively long and slender and gradually taper towards the conically or obtusely pointed end; the surface is roughened, generally all over, on account of quite obsolete and insignificant microtubercles which are scattered over it at rather wide intervals (Pl. III., fig. 3). The axial length fluctuates generally between  $360\ \mu$  and  $680\ \mu$ ; the

breadth of rays at base between  $7\ \mu$  and  $12\ \mu$ . On the membranous oscular margin the size may decrease to  $264\ \mu$  axial length. Exceptionally slender-rayed dermalia, found occasionally by the side of stouter ones, represent without doubt a developmental stage preceding the attainment of definitive dimensions.

The dermalia are found irregularly scattered in the dermal membrane. They can not be said to be numerous; in many places they occur in no greater, if not in somewhat smaller, numbers than the hypodermalia. Altogether, it may be said that the latter with their paratangentials are about as much concerned in the support of the dermal membrane as are the dermalia themselves. (See Pl. III., fig. 10. In this figure, the cruciate spicules drawn in blue represent partly the dermalia and partly the paratangential crosses of the hypodermalia. Through the deeply stained dermal membrane, perforated by roundish gaps or pores, is seen the most peripheral part of the choanosome).

The *gastralia* are represented by both hexactins and pentactins, the latter having the unpaired ray directed distad. I can not definitely state which of the two forms predominates, though in some places I have found several of the former form placed together side by side. In any case the gastralia are on the whole rather sparsely present, being situated in isolated positions. The rays are similar in appearance to those of the dermalia; their length as measured from the spicular center is  $165$ – $176\ \mu$ .

The hexasters are of the following two kinds:

Common but not abundant are the *oxyhexasters* (Pl. III., fig. 3) in the choanosome as well as in the subdermal space. They are characterized by the possession of rather numerous



terminals, of which generally 4-7 are borne on each short principal. They are slender—at any rate not strong—and are distinctly rough-surfaced. Though bent at the base, they are straight for the rest of their length and so diverge from one another as to give a spherical shape to the entire spicule. This measures 114-140  $\mu$ ; on an average 120  $\mu$  in diameter. Cases of a principal bearing less than three terminals probably never occur. Certain it is that hemihexactinose and hexactinose oxyhexasters are both entirely foreign to the species.

The only kind of *discohexasters* present is, as before indicated, comparable to the microdiscohexaster of certain other Rossellids. (Pl. III., fig. 6). They measure only 26-30  $\mu$  in diameter. The convex disc at the outer end of each tolerably strong principal bears a bunch of numerous and exceedingly fine divergent terminals, which end each in a minute terminal knob. The shape of the entire rosette is spherical. In a certain specimen the discohexasters in question were met with only occasionally; in another they were quite common, especially near the dermal and gastral surfaces, where they seemed to be somewhat more numerous than the oxyhexasters.

### Soft Parts and Larvæ.

A glance at Pl. III., figs. 8-11, will show at once that the general arrangement of the soft parts is in essential agreement with what we know of other Hexactinellids.

The dermal membrane (fig. 10) is perforated by numerous pores of various sizes; its tissue separating these from one another is at times quite thin and filamentous, while at other times it is flat and film-like.

The trabeculae are sparsely developed, without doubt on account of the narrowness of the space that they occupy.

Chambers of the usual cup-like or thimble-like shape are 80–150  $\mu$  wide. In a few instances it seemed to me that a chamber freely communicated with a neighboring one through the end which should normally be closed and rounded.

Their wall or the reticular membrane exhibits minute open meshes not more than  $7\frac{1}{2}$   $\mu$  wide (Pl. III., fig. 11). Under a moderately strong power of the microscope, the nodes of the reticulum appear as swollen points somewhat more deeply colored than the delicate beams. Seen under the immersion-system the choanocyte nucleus (about 2  $\mu$  dia.) is discernible not so much by itself as by the fact that the spot is relatively clear of the surrounding protoplasmic granules. It is scarcely stained by the borax-carminine or the hæmatoxylin. In some of my preparations the flagella is occasionally observable, though by no means in a complete state. The collar is unrecognizable.

Close to the thin oscular margin the chamber-layer is represented simply by the reticular membrane disposed in a continuous undulating manner instead of being formed into distinct chambers (upper part of fig. 8). Superiorly, it finally ceases to exist, its disappearance taking place insensibly in that its reticulum gradually passes over into the wider-meshed cobweb of the ordinary trabeculae (fig. 11).

Well-stained archaeocytes, either isolated or grouped together in varying numbers, occur in abundance on the outer side of the wall of the chambers, exactly as I have described in *Euplectella marshalli* (Contrib. I., p. 165) and in *Leucopsacus orthodocus* (Contrib. III., p. 41). Pl. III., fig. 11, shows two such groups of quite insignificant size. The larger of the archaeocyte-congeries

are very conspicuous on stained preparations on account of their compactly packed elements being very deeply colored (seen in Pl. III., figs. 8-10 as deep blackish spots). Though they may take a somewhat irregular shape in accordance with the circumstances of the space occupied by them, the normal shape of the congeries after attaining a certain size seems to be spherical (figs. 13-15). A rather small congeries of  $40\ \mu$  diameter (fig. 13) is already evenly delimited on the external surface, though evidently it is still without a special enveloping membrane or epithelium. It may grow to double or more than double that diameter without showing a morphological change, except of course in the numerical increase of the closely crowded cells. The sharply defined surface presses against the incurrent side of the walls of the chambers, right in the midst of which the body is situated. The extent of the chamber-wall surface in contact with this is such that inceptively several little groups of archæocytes might have taken origin on it; hence it is exceedingly probable that the growth of an archæocyte-congeries takes place not only by multiplication of its elements but also by fusion of originally separate groups.

The archæocytes, taken singly, are only  $2-4\ \mu$  large. Pl. III., Fig. 12, which shows a small group of them as seen in a borax-carminé preparation, is not a good representation in that it fails to indicate the nuclear outline in each cell-body. A renewed examination of the preparations, long after the plate had been printed, brought me to the conviction that here, as I believe in Hexactinellidan archæocytes generally, there exists a greater or less quantity of cytoplasm around the nucleus,—in other words, that we have here to do with small entire *cells* and not with free *nuclei* (*cf.* Contrib. I., pp. 158, 171). The

cytoplasm always takes up stains well, a fact which renders the limit of the inclosed nucleus indistinct. The use of the immersion-system for the examination will make the matter clear, unless the cells are overstained, as is generally the case when hæmatoxylin is used. The nucleus contains from one to several dark granules. It measures approximately  $1\frac{1}{2} \mu$ , which is also about the size of the trabecular nuclei.

*The Larva.*—In the study of the present species I have been able to obtain a somewhat more definite knowledge of the larva, than was possible in the case of *Leucopsacus orthodocus* (*cfr.*, Contrib. III., pp. 42-46). And yet, many points certainly remain to be settled in the future with a further supply of the material.

Of the larvæ which I consider to be fully developed (Pl. III., figs. 20, 21), a single case was discovered in one of the two mother-individuals constituting Sci. Coll. Mus. Sp. No. 228, collected in the month of April; and no less than six cases, besides a number of those representing earlier developmental stages, were found in the third specimen obtained by myself during July. The fourth specimen obtained in November seemed to contain none, although it showed archæocyte-congeries developed in about the same degree as in all other specimens. The above gives a hint as to the season of the year in which the reproduction of the species seems to take place most actively.

In all probability the larvæ arise outside of the chamber-layer in the external trabecular spaces, which is the seat of all archæocyte-congeries. However, I can not definitely state that all the ripe larvæ I have found were invariably in that situation,—or that some of them were not situated in the inner system

of the trabeculæ. A part of my material is contained in sections of the wall of the mother-sponge; the rest was removed from the wall by means of needles under the dissecting microscope and then prepared either in toto or laid out into sections (10–20  $\mu$  thick) with all the cares necessary for the microtoming of such small objects. On examining the preserved sponge-wall with transmitted light, the larva present within could be recognized by its opaqueness and by its peculiar shape; it could thus be isolated without much difficulty.

The larva in the fully developed state is spindle-shaped, the broadest part of the ventricosity lying not in the middle but nearer to one of the pointed ends than to the other (figs. 20 and 21). The broader half of the body is presumably the anterior. Total length of body, 275  $\mu$ ; greatest breadth, 88  $\mu$ . Cross-section of the body, circular.

The oldest larva I have seen in *Leucopsacas orthodocus* and which I have figured in my Contrib. III., Pl. III., fig. 25, is approximately spherical in shape (about 100  $\mu$  dia.). If I am right in considering that larva to be fully developed or at any rate not far removed from that stage, it follows that Hexactinellidan larvæ are subject to a certain variation as regards their external form.

In the larva of the present species, a distinct *epithelium*, 4  $\mu$  thick at the thickest part and consisting of approximately cubical cells arranged in a single layer, covers the external surface for at least the greater part of its extent. Towards both narrowed ends of the body, the layer gradually grows thinner, finally to become altogether unrecognizable. I hold it probable that the covering layer is in fact wanting at the poles, leaving

the inner mass exposed at these parts. The cell-bodies take up stains well, on which account evidently the nuclei can not be perceived with any degree of distinctness. Notwithstanding this fact it seems assumable that the single bodies here taken for the cells are not merely nuclei by themselves. The cells, as seen in both cross (fig. 21) and tangential (fig. 19) sections, are separated from one another by narrow clear spaces.

Internally against the inner mass the covering layer is sharply delimited. On the external surface, so far as the presence of the layer can be demonstrated, there is a coating of quite clear appearance, showing a sparse granulation which here and there assumes the form of a vertical striation. I think there is no doubt whatever that this coating represents the flagella, which have deteriorated as the result of the application of reagents. The same was observed likewise in the larva of *Leucopsacus orthodocus* (Contrib. III., p. 43); therefore the Hexactinellida seem to offer no exception to the rule that the sponge-larva is provided with an external layer of flagellated cells.

The *inner mass*, as seen in toto preparations under a moderately high power of the microscope (Pl. III., fig. 20), appears, leaving aside the spicules, simply as a dense assemblage of well-stained corpuseles, much like a large congeries of the archæocytes before spoken of. Closer observations on serial sections (subjected to after-staining with hæmatoxylin or hæmatein-alum or with either of these in combination with eosin, &c.) reveal that to a certain degree histological differentiation already exists among the elements of the mass (Pl. III., fig. 21).

Peripherally and right under the external epithelium, the corpuscular elements, in respect to which it is difficult to deter-



mine whether we have to do simply with nuclei or with cells inclosing each a nucleus, are very small and compactly packed together. I am rather inclined to view them, as in the case of certain more internally situated elements (archæocytes) of similar appearance but of a somewhat larger size, in the light of complete cells. The spicules, to which I shall soon return, run for the most part in the peripheral layer just referred to. At the two poles of the larval body, which are apparently destitute of the external epithelium, cellular elements are not recognizable; whatever sparse quantity of the protoplasm exists over and between the bundled spicular rays simply appears finely granular.

The more internal and by far the principal part of the inner mass is composed of at least two kinds of cells, *viz.*, those which go to form a reticular kind of tissue and those which retain a more or less spherical shape (fig. 21). The former most likely correspond to the so-called "dermal cells", and the latter to the archæocytes, known in the inner cellular mass of non-hexactinellidan sponge-larvæ.

The reticular tissue is most plainly visible in the anterior part of the body, in front of the region where this is broadest (see fig. 21). There it presents a small and open meshed, cobweb-like appearance, consisting of irregularly branching and anastomosing filaments, which are well stained and tolerably sharply defined in contour. The small corpuscles occasionally contained therein, I take for the nuclei. What nature to ascribe to the fluid, which, though imperceptible, undoubtedly fills up the spaces of the meshes, is difficult to directly determine. On the other hand, I am strongly inclined to assume that we have in the reticulum an inceptual trabecular system, which, in my opinion (Contrib. I., p. 164), represents at once both the

connective-tissue cells and the pinacocytes of the Monaxonia and the Triaxonia. The two kinds of cells just mentioned are both the outcome of the larval "dermal cells", which in the Hexactinellida seem very early to take the form of trabeculae.

If I am right in the above assumption concerning the morphological nature of the larval reticulum, the spaces in it or the meshes are simple interstitial lacunae, which later (after the immigration of the external flagellated cells inwards to form the chambers) should come into free communication with the external world. From this standpoint it is exceedingly questionable if the fluid contained in them is to be regarded in the light of a connective-tissue mesogloea, which, moreover, is something apparently totally undeveloped in the adults (Contrib. I., p. 161). It seems more likely that the fluid is simply imbibed water,—an assumption which suggests itself as being by no means improbable.

The reticulum can be traced, from the anterior region before referred to, backwards into that lying posterior to the broadest part of the larval body. In fact it may be said that the reticulum pervades almost the entire inner mass. Only, in the more extensive posterior region just indicated, forming about four-fifths of the entire mass, it is not quite plainly visible, this being probably due to the crowded co-existence here of small and approximately spherical cells. Moreover, the meshes here are on the whole considerably wider than in the small anterior region which lacks the said cells. It may not be improper to consider that in a measure their greater width stands in relation to the presence therein of the cells in question.

These cells, which probably deserve to be called simply the archaeocytes, measure only  $2-2\frac{1}{2}$   $\mu$ . As in the case of the same

cells in the mother sponge, the cytoplasm is deeply stained and thus makes indistinct the outline of the nucleus, which, excepting the few chromatic granules contained in it, does not surpass but rather falls behind the cytoplasm in staining capacity. Further like them, the larval cells in question either adhere to the reticulum (the trabecule) or lie heaped together in the meshes (the trabecular spaces). They are by no means uniformly packed in, but are for the most part irregularly and apparently rather loosely arranged, so that there exist between them vacant gaps, evidently parts of the lacunar system traversed by the reticular filaments. The gaps may be of quite an insignificant extent, though at other times they may measure  $14\ \mu$  across. While many of them are irregular in outline, others present a more or less roundish section and then may be bordered, either partly or nearly all around, by an epithelium-like row of the cells. Such an appearance gives one the impression that he has before him follicle-like structures; and at first I even thought of the possibility of their representing the *Anlagen* of the chambers. However, after more concentrated observations, I have had to throw off this illusion, because: firstly, several closely situated follicle-like spaces, though apparently distinct at first sight, could often be demonstrated to be parts of a continuous lacunar space; secondly, they are at places found to be partitioned from one another by a single row of the cells, which should not be the case if each were a follicle having a wall of its own; and thirdly, it not infrequently happens that the inner space is distinctly traversed by the filaments of the reticulum. After all, I believe the cellular mass is simply honeycombed, as it were, by a system of interstitial lacunæ, which are the same as the meshes of the reticulum. In other words it may be said that the cells are, at least

in part, arranged in reticular tracts in the same way as those in the oldest larva I have seen of *Leucopsacus orthodocus* (Contrib. III., p. 46; Pl. III., fig. 25), the cellular tracts occupying the same space as the trabecular reticulum with which they are joined together.

As to the probable origin of the chambers during the metamorphosis, I can here do no more than refer the reader to the considerations I have laid down on p. 163 of my Contribution I.

Now as to the spicules of the larva. As before stated, they lie mainly in the periphery of the inner mass,—close under, but not in direct contact with, the external epithelium. As in the larva of *Leucopsacus orthodocus*, they are all stauractins (*cfr.* pp. 44–46, Contrib. III.). They are always so oriented in relation to the form of the larva that we may speak of the transverse and the longitudinal axes (Pl. III., fig. 20). The former is always the shorter, and the two rays in it are usually of about equal length. Of those forming the longitudinal axis, one is as a rule much longer than the other. The four rays are in a plane more or less concave on the inner side, in conformity with the curvature of the body-surface. In the manner of distribution of the spicules, a strict regularity is not observable beyond the fact that the centers lie well separate from one another, the result being that the rays run singly without coming together into bundles. They are of such a length that intersection is of frequent occurrence: there is thus brought about a latticework, the meshes of which may be said on the whole to be rectangular but not regular in shape. Towards each pole of the larva, a number of longitudinally running rays converge and there come

together into a bunch, thence to project their pointed ends for a short distance out of the soft tissue.

Finally, some remarks on the development.

In all appearance the larva originates from the archæocyte-congeries of the mother individual. In this respect I have nothing to add to what I have said in Contrib. I., pp. 187-190, and in Contrib. III., pp. 42, 43.\* Pl. III., figs. 13-15, will give a fairly good idea of how archæocyte-congeries of various sizes appear in sections. In them the external epithelial layer of the larvæ is still undeveloped. This comes into formation when a congeries has attained a diameter of 90-100  $\mu$ , by which time it is invariably spherical in form. I must say that there can not be discovered in my series any stages which show the exact manner of the formation of the external epithelium. Nevertheless, I think it will not fall wide of the mark to assume that the peripheralmost cells in a congeries, which has grown to the proper size, take the epithelial arrangement and thus differentiate themselves as a layer from the inner cellular mass. Possibly this takes place synchronously with the development of flagella by the said cells. At any rate, the remnants of flagella in the form of a clear, granular or striated-like crust are observable as soon as the external epithelium has established itself as such. Whether the epithelium is at first formed alike all over the spherical embryo, must be left undecided. The appearance of

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\* In some of the sections of *Vitrollula fertilis* I have met with a few cases of veritable eggs which were undergoing the cleavage process. They measured about 100  $\mu$  and were of a dark appearance owing to the abundant presence of deutoplasmic granules which completely hid the nuclei. However, I have made myself sure of the fact that they did not belong to the sponge, but to a small Crustacea which lived in the sponge-wall,—a fact which could at once be foretold from the very appearance of the vitellus.

the inner cellular mass at this stage differs in no way from that of a simple archæocyte-congeries.

The spicules appear shortly after, in embryos of 110–130  $\mu$  diameter, in the same shape and position as I have described for the same embryonal stage of *Leucopsacus orthodocus* (Contrib. III., p. 44). (See Pl. III., figs. 16 & 17). They are all minute oxystauractins and are situated in the periphery of the inner mass and at a short distance from its limit against the external epithelium. They are distributed, widely apart from one another, in a single layer running parallel to the external contour of the spherical body. The plane of the four rays in each spicule coincides with that of the layer and is therefore slightly concave on the inner side. In the earliest developmental stage of the oxystauractins (fig. 17) that I have seen, the axial length measured 15  $\mu$ . The central node was flat and disc-like and was relatively large in comparison with the small spine-like rays. I did not succeed in bringing the axial filaments into view, nor could any of the cells directly adjoining the spicules be distinguished from the rest as scleroblasts. It is most unsatisfactory that the spicules could not be observed at the very beginning of their development. For such minute observations the methods I have used seem to have been inadequate.

Some time after the appearance of the spicules, the embryonal body begins to elongate and assumes for a time an ovoid shape. Pl. III., fig. 18, shows an embryo in this stage of development. It is apparently in longitudinal section, but I am not in a position to state exactly the direction in which it had been cut, since it was found in the wall of the mother sponge which had been sectioned without any knowledge of its presence. As it appears on the section in question, the flagellated layer invests the body on



the sides as well as at both ends,—in fact, all around. That this represents the true condition can be asserted only under the assumption that the section really passed through the two poles, which is however not certain. I regret that the point could be determined neither on other sections of the same embryo nor on any other of the material in hand.—The inner mass now shows an advance in that the reticulum, before described from fully developed larvæ, is distinctly observable in it. The open-meshed reticulum is for the most part situated at the periphery in one moiety of the body, which moiety is then probably to be regarded as the anterior. The cellular elements lie densely crowded in the central as well as in the posterior parts of the mass. There exists a distinct indication that the reticular and the cellular tracts penetrate to a certain extent into each other. In the latter tract there occur a few irregular slit-like gaps. The oxystauractinic spicules are still quite small.

Intermediate stages leading over the one just described to the fully developed larva were not discovered; but it will not be difficult to imagine the changes by which the form and organization of the latter is reached.

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#### CRATEROMORPHA J. E. GRAY.

Cup-like or bowl-like, firmly attached by distinct stalk; large or moderately large. Excurrent canalar apertures on gastral surface probably always freely open. Stalk generally not tubular but traversed by a system of anastomosing (excurrent) canals. Parenchy-

malia diactins, in addition to which medium-sized hexactins may sometimes occur. Pentactinic hypodermalia with regularly cruciate paratangentials, always present. Dermalia, rough pentactins or stauractins or both. Gastralia, generally similar pentactins and sometimes stauractins. Oxyhexaster as a rule normally developed. Discohexaster in one form, which is usually small (microdiscohexaster with diameter under  $50\ \mu$ ), but may be of a considerably larger size ( $80\text{--}120\ \mu$  dia.).

In the Challenger Report F. E. SCHULZE instituted a genus *Aulochone* as distinct from *Crateromorpha*. In '97 (p. 539) the same investigator included the former under the latter, thus joining the two genera into one, on account of the far reaching agreement in spiculation. However, I think the distinction between the two genera mentioned may be kept up in view of the fact that, while *Crateromorpha* possesses pentactinic hypodermalia, *Aulochone* is altogether devoid of these,—a sort of difference analogous to that which separates *Acanthascus* from either *Rhabdocalyptus* or *Staurocalyptus*.

Under *Aulochone* as a distinct genus may be placed not only F. E. SCHULZE's original *A. cylindrica* (from the Kermadec Is.) and *A. lilium* (from the Meangis Is.) but also the South African species recently described by R. KIRKPATRICK ('02) under the name of *Crateromorpha lankesteri*.

To the genus *Crateromorpha* I refer the species and varieties embodied in the following

*Differential Key to the Species.*

- a.*—Dermalia, exclusively or predominantly pentactins. Discohexaster, spherical, up to about 50  $\mu$  in diameter.
- a*<sup>1</sup>.—Dermalia intermixed with some stauractinic forms. Hypodermal pentactins not conspicuously thick-rayed (not over 100  $\mu$  in breadth of rays at base).
- a*<sup>2</sup>.—Sponge-body smooth on the outside, the entire sponge being exquisitely wine-glass-like.....*C. meyeri* J. E. GRAY. (Philippines; Sagami Sea).
- b*<sup>2</sup>.—Sponge-body with rounded tubercle-like prominences on the outside.....*C. meyeri tuberosa* IJ. (Sagami Sea, Suruga Bay).
- c*<sup>2</sup>.—Sponge-body with numerous wrinkle-like ridges and irregular prominences on the outside.....*C. meyeri rugosa* IJ. (Sagami Sea).
- b*<sup>1</sup>.—Dermalia exclusively pentactins. Hypodermal pentactins have rays of striking thickness (300  $\mu$  or more at base).....*C. pachyaetina* IJ. (Off Shikoku, Japan).
- b.*—Dermalia, exclusively or predominantly stauractins.
- c*<sup>1</sup>.—Discohexaster rather large (80–120  $\mu$  dia.) and strong-rayed; spherical. No hexactins among the parenchymalia .....*C. tumida* F. E. SCH. (Banda Is.).
- d*<sup>1</sup>.—Discohexaster small (up to 50  $\mu$  dia) and delicate.
- d*<sup>2</sup>.—Sponge-body with tortuous exterior, the depressions leading into intercommunicating intercanals. No hexactins among the parenchymalia. Discohexasters all spherical.....*C. corrugata* IJ. (Sagami Sea).
- e*<sup>2</sup>.—Sponge-body with smooth exterior; without intercanals. Medium-sized hexactins present among the parenchymalia. Most discohexasters with the terminals formed into six separate bunches (not spherical) .....*C. thierfelderi* F. E. SCH. (Little Ki Is.).

**CRATEROMORPHA MEYERI J. E. GRAY.**

Plate IV., figs. 1–8 and 12.

*Crateromorpha meyeri*. H. J. CARTER, '72, p. 112.—J. E. GRAY, '72, p. 136.—H. J. CARTER, '73*a*.—H. J. CARTER, '73*b*, p. 361.—H. J. CARTER, '75, p. 199.—W. MARSHALL, '76, p. 125.—F. E. SCHULZE, '86, p. 52 (reprint).—F. E. SCHULZE, '87, p. 161, pl. LXI (!).—F. E. SCHULZE, '97, p. 540.—I. IJIMA, '98, p. 48.

*Hyalonema anomalum*. J. S. BOWERBANK, '77, p. 461 (*vide* F. E. SCHULZE '87, p. 188).

Besides the typical *Crateromorpha meyeri* I recognize two varieties or subspecies of it, *viz.*, *C. meyeri tuberosa* and *C. meyeri rugosa*. These will find special treatment later and here I restrict my account to the typical species. As such I consider those forms of the group which are exquisitely wineglass-like or tulip-like in shape and have the evenly rounded sponge-body,—forms, which have long been known from Cebu and are also found in the Sagami Sea.

According to the accounts of the Cebu specimens by CARTER, GRAY and SCHULZE the species occurs in that locality on a blue mud ground of 174 m. (=95 fms.) depth. It may reach 7 inches (say, 180 mm.) in total height; the stalk, which may be  $7\frac{1}{2}$  inch (say, 16 mm.) thick, being of nearly the same length as the body proper. The latter has a smooth external surface; its wall is thick but becomes very thin at the oscular margin.

In the Challenger Report (p. 164) it is mentioned that a dried *Crateromorpha meyeri* was found among the sponges that had been collected by DÖDERLEIN at Enoshima. Probably it was a representative of the typical species. To me, at any rate, two specimens have thus far become known from the Sagami Sea, both of which agree well in shape with the Philippine forms.

First may be mentioned the fine specimen preserved in formalin, which belonged to Mr. ALAN OWSTON and was kindly shown me by that gentleman. It came from a depth of 365 m. in the neighborhood of Okinosé. Total height, 114 mm. Stalk, 30 mm. long. Greatest diameter of body, 67 mm. Osculum, 63 mm. in

diameter. Surface smooth all over. The one point specially worthy of note was the relative shortness of the stalk bearing the elongate sacciform body.

The second specimen (Sci. Coll. Mus. No. 364) is the one shown in Pl. IV., fig. 1. Locality, Outside Okinosé by the Iwado-line; 429 m. (235 fms.). Total height 115 mm., of which about 55 mm. belong to the stalk. This is of uneven contour, measuring 9-13 mm. across. In the lower two-thirds of its length it is quite hard and close-textured owing to spicular ankylosis, while the upper portion presents a longitudinally fibrous appearance. The lower end is thickened into an irregular basal enlargement, by means of which the sponge is fixed to the firm, finely grained, tufaceous substratum.

The bulging, cup-like body somewhat closes above but soon flares out at the simple-edged oscular rim. It is irregularly roundish in cross-section, with a diameter of about 50 mm. at its middle. The osculum is 35-40 mm. in diameter. The sponge-wall is thin and membranous at the rim but thickens below, attaining a thickness of 10-12 mm. near the insertion of the stalk.

The smooth external surface, when seen under the lens or even with the naked eye, shows the delicate and exceedingly fine-meshed dermal layer, which is supported by a much coarser hypodermal network composed of straight, but often interrupted, streaks of tolerably uniform fineness and showing small angular meshes, usually not exceeding half a millimeter in length of sides (Pl. IV., fig. 6). The hypodermal beams are finer than those in either *C. m. tuberosa* or *C. m. rugosa*, and do not form continuous strands of such length, which fact has its ground in a certain difference in the spicular elements composing them.

But of this later.—The apertures of incurrent canals, visible through the dermal layer, are small, not exceeding 2 mm. in diameter, even in the middle of the body where the largest occur.

On the gastral surface the apertures of excurrent canals open freely. Near the oscular margin they are all small; lower down, larger ones add themselves to the small, and in the lower half of the cavity the largest may measure 4-5 mm. across. Centrally at the very bottom there exists a space occupied by a few small apertures only; peripherally it runs out into five or six, septa-like, radial ridges, the interspaces between which are taken up by closely crowded excurrent apertures.

The compact stalk is traversed by a system of anastomosing excurrent canals as in most *Crateromorpha* (not simply tubular as in *C. thierfelderii*). Externally it lacks the dermal layer which must have fallen away.

The sponge as preserved in alcohol is colorless. So also the formalin specimen belonging to Mr. Owston. It is pure white after desiccation. KUMA states that the Sci. Coll. specimen, which was obtained by him, was in the fresh state "yellow like the yolk of a hen's egg."

Both specimens examined by me contained a large colony or colonies of *Syllis ramosa* M'INTOSH. This remarkable Annelid seems to be seated mainly in the excurrent canal-system, stretching out in part into the gastral cavity. When the sponge is dried it may still be recognized, as its colored body adheres to the white sponge-tissue. The specimens I have taken from the *C. meyeri* in possession of the Sci. Coll. were studied by Prof. A. OKA (Ueber die Knospungsweise der *Syllis ramosa*.—Zool. Mag., Tokyo, Vol. VII. [1895], p. 117).



### Spiculation.

The spiculation was studied principally on the Sci. Coll. specimen (No. 364). I am also greatly indebted to Professor, F. E. SCHULZE for a gift of slide-preparations made from Cebu specimens, which have been invaluable for the purpose of comparison. As in external form, so also in spiculation I observe an essential and far-reaching agreement between the Japanese and the Philippine specimens.

The *parenchymalia* are mainly diactins, among which hexactinic forms are occasionally intermixed.

The diactinic *parenchymalia* are as usual of varied dimensions, ranging from filamentous comitalia up to principalia of 5 mm. or more in length and 80  $\mu$  in thickness in the middle. The larger diactins are met with more especially in the deeper parts of the body, close to the canalar and the gastral surfaces. They are bow-like or elongate spindle-shaped; smooth throughout (not roughened at ends), without central swelling or knobs and gradually running out to the pointed ends. This refers more especially to the larger diactins of the body proper; those of the stalk are generally roughened at the ends, which are often rounded instead of being pointed. The thinner diactins, which occur either isolated or as comitals, are smooth at the center or show there at most a weak annular swelling; their ends are always roughened and either swollen and rounded or attenuated to a point.

The isolated oxyhexactinic *parenchymalia* (some shown in Pl. IV., fig. 7) are of a medium or moderately large size. They may approach the dimensions of a hypodermal pentactin but are generally considerably smaller. The rays are smooth and straight

or nearly straight. F. E. SCHULZE does not mention these hexactins in his descriptions but has not omitted them in his figure (Chall. Rep., Pl. LXL, fig. 3); indeed I observe their presence in the preparations from Cebu specimens. Such parenchymalia are known to exist not only in *C. meyeri*, but also in the subspecies *tuberosa* of the same as well as in *C. thierfelderi*. In the remaining members of the genus they seem to have disappeared altogether, leaving the parenchymalia composed exclusively of diactins, so far at least as those of the sponge-body are concerned.

In the upper one-third of the stalk the parenchymalia seem to consist only of longitudinally disposed diactins which are densely grouped together but free. Synapticular connections between them commence to occur at about the beginning of the lower two-thirds of the stalk. At the same time there begin to appear, among the diactinic parenchymalia of the region, small hexactinic—and occasionally pentaactinic—elements (Pl. IV., fig. 8), the rays of which are comparatively short and thick, have rounded ends and show inconspicuous microtubercles on the surface either all over or near the ends only. The spicules in question are at first free but soon become fused to one another as well as to the diactinic parenchymalia of the region in irregular orientation. Consequently, in about the middle of the stalk the skeleton is already entirely represented by a dense and stony siliceous framework, except for isolated oxyhexasters lying loose in the meshes. The small hexactins just mentioned I regard as homologous with those which I have called the *basidictyonalia* in other lyssacine Hexactinellids. They have been mentioned and well figured by F. E. SCHULZE (Chall. Rep., Pl. LXL, figs. 5, 6 & 8).

The *hypodermalia* are mainly oxypentactins of a comparatively large size and with rather strong rays. The paratangentials may be 1.5 mm. long and the unpaired proximal ray, 2.5 mm. The rays at base may attain a thickness of 100  $\mu$ . The pointed ends of rays usually show no roughness of surface. There occasionally occur exceptionally small and thin-rayed oxypentactins, situated somewhat deeper than those of more normal size; they probably represent early stages in the development of the hypodermalia. The meshwork formed by the paratangential crosses is irregular (Pl. IV., fig. 6).

In addition to the pentactinic hypodermalia there are observed at intervals slender diactins, which, running either solitarily or in small bundles, are in direct contact with the dermal layer and so serve as its support. They are thus to be regarded likewise as hypodermalia; however, it must be said that as such they play only a subordinate rôle in comparison with the pentactinic forms. In the Sci. Coll. specimen the diactinic hypodermalia are quite few and far between; in the larger specimen belonging to Mr. Owston, they are somewhat more numerous. It may be that as the sponge increases in size, their number is more or less augmented by transference from the ranks of the parenchymalia. It will later be seen that in large specimens of both the subspecies *tuberosa* and *rugosa*, the numerical ratio of pentactinic to diactinic hypodermalia is reversed, the latter greatly predominating over the former in numbers. But it is of course impossible to predict that the same will ultimately take place also in the typical species after a great advance in growth.

There exist in this species no spicules, which can be specified as the hypogastralia.

The *dermalia* are rough pentactins; occasionally stauractins (Pl. IV., figs. 2 & 3). The rays are on an average  $130\ \mu$  long as measured from the center and  $7.6\ \mu$  thick. They scarcely taper outwards at all or do so in but a slight degree. The ends are rounded. Not infrequently the pentaactinic form, in which the unpaired ray is always directed proximad, shows an indication of the sixth distal ray in the form of a knob. The paratangential cross is usually—but not always—more or less convex on the outside, which is due more to the rays concerned being not quite at right angles to the radial axis, rather than to the curvature of the rays themselves. Seen surface on, the delicate dermal latticework (Pl. IV., fig. 6) presents irregular meshes, though in places these show a tendency to assume a regular quadrate arrangement. Here and there occur unusually small and slender-rayed dermalia—in all probability not fully developed—in which the rays are but obsoletely rough and run out to fine points.

On the thin oscular margin the dermalia present are all stauractins. These and some thin diactinic parenchymalia seem to be nearly all the spicules that enter into the support of that part.

The *gastralia* are pentactins, but sometimes stauractins and rarely even diactins. The rays are characterized similarly to those of the dermalia; only they are frequently of a much greater length, while the microtubercles of the surface occur somewhat more sparsely. Without forming a continuous layer the spicules in question are irregularly distributed over the choanosomal surface facing the gastral cavity.

The same kind of spicules as the gastralial just mentioned, are present on the surface of the excurrent canals. These may then be called the *canalaria*. They are most frequently met with in the widened proximal region of the canals, directly adjoining the apertures into the gastral cavity. It may safely be concluded that the same kind of lining spicules, whatever be their names, extends from the gastral cavity into the excurrent canals. Following the latter distad towards and into their narrower branches, the *canalaria* become more and more scarce until they cease altogether to exist.

To be explicit, the *canalaria* are, mostly at any rate, rough pentactins with the unpaired ray directed distad. So far as those in the body proper are concerned, I have not seen hexactinic forms amongst them, but I believe that some might possibly have been discovered, had a more extensive search been made. On the other hand, in preparations of tissues from the upper part of the stalk, I find a considerable quantity of regular hexactins occurring together with pentactins. All these spicules are quite like the gastralial in appearance and without doubt represent the *canalaria* lining the excurrent passages in the region mentioned. For Philippine specimens F. E. SCHULZE ('87, p. 163; '97) has given rough oxyhexactins as the *canalaria* generally. I find this fully borne out by the preparations of a Cebu specimen at my disposal. Nevertheless, the difference here indicated as regards *canalaria* I regard as probably inconstant and therefore as being not of systematic importance.

Of the hexasters, the *oxyhexaster* (Pl. IV., fig. 5) occurs abundantly in the choanosome. Diameter, 90–120  $\mu$ . Each very short principal bears usually 2–3, sometimes 4 and even 5,

straight or slightly bent, obsoletely rough or nearly smooth, divergent terminals. There are in some oxyhexasters perceptibly more slender than in others.

The small *discohexaster* (Pl. VI., fig. 4) may be said to be spherical in shape; the terminals emanating from each principal do not form a distinctly separate tuft, as seems to have been the case in the specimens studied by F. E. SCHULZE, Diameter, 45–50  $\mu$ . As shown in the figure referred to, the minute terminal discs often appear as if they were situated in the periphery at unequal distances from the central point. I think this is due, not so much to actual differences in the length of the terminal rays as to the various directions in which these are viewed. The said discohexasters are scattered in moderate abundance in the subgastral region as well as along the surface of the excurrent canals. They are somewhat more common in the latter region than in the former. F. E. SCHULZE ('97) found the rosette in question generally shifted out to the free ray-tip of oxyhexactinic canalaria. Similar instances were observed also by me, in which a rosette hung on the free end of a stray parenchymalia-ray that projected into the canalar lumen.

### CRATEROMORPHA MEYERI TUBEROSA IJ

Pl. IV., fig. 9; Pl. V., figs. 12 & 13.

*C. meyeri* var. *tuberosa*. IJIMA, '98, p. 49.

Of the specimens which I refer to a subspecies of *C. meyeri* under the above trinomial designation, several (no less than



fourteen) have come under my observation. The localities in the Sagami Sea, so far as known to me, are: Outside Okinosé (about 429 m.), whence came most of the specimens; Homba (about 572 m.); and a spot a few miles E. of Habu, Vries Island. North of the latitude of Okinosé in the sea mentioned, no specimen as yet seems to have been obtained. Whereas in the Suruga Bay, on a rich *Metacrinus* ground near Enoura and of only about 80 fathoms depth, the "Albatross" (Stat. 3719; May 11, 1900) trawled up a badly macerated specimen which at the time seemed to me to belong to the present subspecies.

A specimen from Homba (Pl. V., fig. 12) was growing on a loose stone covered all over with remains of Bryozoa, worm-tubes, &c. Others from Outside Okinosé are attached to black

lava, to masses of volcanic detritus or to some shells (in one case to a *Balanus* and in another to a Brachiopod). *Syllis ramosa* seems to be a very frequent, if not a constant, companion of the subspecies; at least I have been able to determine the presence of that commensal Annelid in all specimens (seven in number) from Outside Okinosé.

This lot of Okinosé specimens is of further interest in that it comprises a graduated series of differently sized individuals of the subspecies, the



Text-figure 1.

*Crateromorpha meyeri tuberosa* 15.  
 $\frac{2}{3}$  natural size.

extremes representing the smallest and the largest I have as yet seen.

To mention a few specimens in particular. The smallest just referred to is the one shown in the accompanying text figure 1, *A* (S. C. M. No. 478). It is only 42 mm. high, the stalk being nearly as long as the body proper. The latter is 18 mm. broad. The presence of tubercular prominences on this small specimen as also on such gradationally larger ones as measure 57 mm., 73 mm., 85 mm., &c. in height, shows that their formation takes place very early in the life of the individual.

Text-fig. 1, *B*, represents a moderately large specimen with the typically characteristic shape of the subspecies. (From Outside Okinosé, S. C. M. No. 482). Total height, 115 mm. Greatest breadth of body, 63 mm.

Pl. V., fig. 12, shows in half natural size the single specimen I have from Homba (S. C. M. No. 444). Total height, 139 mm. Greatest breadth of body, 100 mm. The irregular protuberances of the body are 10–30 mm. or more in height. In places the surfaces of directly adjoining protuberances have come into contact and have fused together leaving an arch-like passage between them. The stalk is of about the thickness of one's thumb.

Fig. 13 of the same plate depicts the largest specimen (S. C. M. No. 445, from Outside Okinosé by the Iwado-line) that has come under my observation; it is cut open lengthwise, so as to show the gastral surface and the system of excurrent canals traversing the stalk. Total height, 210 mm. Thickness of wall, 7–10 mm. in the lower part, without taking the outbulging into consideration.

Summarily speaking, the general appearance of the sponge is essentially like that of the typical species, except in the fact already indicated that the external surface of the body proper is irregularly and conspicuously uneven on account of large and small rounded protuberances. These are usually only slightly or not at all developed along the rim of the cup-like body for some distance from the thin oscular edge. Lower down and on the remaining portion of the body, they exist in indefinite numbers and distribution (typically as in text-fig. 1, *B*). Noteworthy is the fact that in four cases I have found the bosses, scarcely developed on one side of the body, instead of being present all around as is usually the case, so that that side appears nearly smooth. Further, in several specimens the body is found to be laterally compressed to a greater or less degree, the osculum then presenting a correspondingly oblong shape. The firm-looking stalk, which is generally of an irregular outline in cross-section, makes up  $\frac{1}{3}$ – $\frac{1}{2}$  of the entire height of the sponge. It may be covered over by a crust-like coating of dermal and hypodermal pentactins, which however are easily detached.

Some of the freely open excurrent apertures on the gastral surface (Pl. V., fig. 13) are of a conspicuously large size. This is owing to the larger caliber of the excurrent canals which penetrate into the parietal bosses. When such a canal is excessively widened it may appear more like a niche in the wall of the gastral cavity than a tube, though it seems that the boss always arises as a thickening of the wall and not by an evagination of this. The bottom of the gastral cavity is occupied centrally by a space which peripherally runs out into radial septa-like ridges and on which open comparatively small apertures leading into the canal-system of the stalk.

### Spiculation.

The various spicular elements are in essential agreement with those of typical *C. meyeri*. I may therefore confine my account of the spiculation to only those points which for one reason or another seem to me to be worthy of special note.

Among the parenchymalia, which are predominantly diactins, there are occasionally observed hexactins of moderately large size. This is exactly as in the typical species but is here specially mentioned, since in the subspecies *rugosa* I have failed to discover any parenchymalia of hexactinic shape.

In all the larger specimens, the hypodermal strands as seen with the naked eye or under the lens are on the whole somewhat coarser (up to 90  $\mu$  in thickness) and therefore more distinctly visible than in the individuals I have seen belonging to the typical species. Moreover, they extend continuously to considerable lengths without becoming broken at short intervals in course. By branching and by intersecting with one another they form a fine meshwork with small angular meshes. Microscopic examination shows that these hypodermal strands consist mainly of fine diactins in fascicular arrangement. Pentactinic hypodermalia in combination with the strands are comparatively sparse (cfr. p. 63), though they occur abundantly on the stalk. The wide difference in character between the hypodermal lattice-work as described above and that known to me from the typical species will be apparent by comparing figs. 11 and 6 in Pl. IV. However, the difference is apparently one which becomes pronounced only after the subspecies under consideration has grown to a certain large size. Thus, in the smaller specimens—say, in those not over 100 mm. or so in height—the diactins and the

hexactins are either nearly equally represented or the latter predominate over the former in numerical proportion, in which cases the hypodermal structure as regards its composition is much the same as in the typical species. In the smallest specimen at my disposal (text-fig. 1, *A*), the hypodermal latticework is scarcely developed as such and can not be distinguished from the choanosomal feltwork.

The canalaria, which I have seen in both incurrent and ex-current canals, are rough pentaactins with or without a rudiment of a sixth ray; occasionally they are stauractins or hexactins, though in some individuals the latter form may be said to be even abundant.

Of the hexasters, the microdiscohexasster (Pl. IV., fig. 9) is met with in moderate abundance in both the subdermal and subgastral regions. The terminals are perceptibly finer than in the typical species as exemplified by specimens from both Cebu and the Sagami Sea, but this may be a variable character. The diameter ranges from 38  $\mu$  to 50  $\mu$ .

### CRATEROMORPHA MEYERI RUGOSA var.

Pl. IV., figs. 10, 11 : Pl. V., figs. 14, 15.

*C. meyeri* var. *rugosa*. IJIMA, '98, p. 49.

This subspecies is established on the strength of five specimens. One of these belonged to Mr. ALAN OWSTON (O. C. No. 6377); the rest are all in the Sci. Coll. Museum. The known localities are Outside Okinoshima by the Iwado-line and Homba (about 572 m.), each of which localities has thus far yielded two

specimens. The grounds may be said to be the same as those from which came both *C. meyeri* and *C. meyeri tuberosa*. Assumably the three forms thrive under different physical conditions of the bottom, and the possibility can certainly not be excluded that they represent what BIDDER has recently called "the metamps."

Subspecies *rugosa* is shaped much like *tuberosa* but is characterized by the fact that the external surface of the body proper, except close to the thin oscular margin, is extremely uneven on account of numerous wrinkle-like ridges and other irregular prominences. The sponge may grow to a respectable size, measuring 320 mm. in height, as attested by one specimen in the Sci. Coll. (Mus. No. 503, from Okinosé). In that specimen the stalk length is about equal to only one-fourth of the total height; it broadens above to an unusual extent, so as to assume an inverted conical shape. The body proper is unfortunately much shrunk and partly destroyed.

Very well preserved are the two specimens shown in Pl. V., figs. 14 and 15, and hence they may be taken as models for description. Though they are about the smallest I have had, the height measures nearly 240 mm. in both. The stalk is nearly as long as the body, near the small and irregular attachment disc is about as thick as one's finger and gradually thickens above towards the junction with the body. It is throughout compact-looking, being partly covered by a dense coating of dermal spicules which easily fall off, and partly firmly felt-like on account of the exposed parenchymal fibers that run in the main longitudinally. Lengthwise it is more or less prominently ribbed in the upper part, the ribs passing above into the superficial irregularities of the body proper.



This stalk expands somewhat abruptly at its upper end; it is more or less distinctly compressed laterally. In the specimen of fig. 15, the major transverse axis of the body measures 172 mm., the minor falling short of it by nearly 50 mm. The wall, which is thin along the oscular edge, shows a considerable thickness below. The osculum is large and wide, being of an oblong shape though quite irregular in outline. The irregularities of the external surface, which form the most conspicuous feature of the subspecies, are apparently due: firstly, to the thickening out of the wall into protuberances similar to those of *tuberosa*, these being generally most prominent in the lower part of the body; and secondly, to the fact that the general surface is thrown into low and sharp-edged wrinkles, such as arise on certain soft substances when they become parched. In the sponges before us there can be no doubt whatever that the rugosity is something natural to them and not a postmortem feature.

Except in the above character, the texture and general appearance of the sponge are in essential agreement with typical *C. meyeri* but especially with the subspecies *tuberosa*. I may specially mention that as regards the appearance of hypodermal strands and of the gastral surface (see fig. 15), what I have said under *tuberosa* is equally applicable here.

The agreement extends to the spiculation also. But there exists one, probably not unimportant point of difference in the fact that in no specimen of *rugosa* have I found hexactins among the parenchymalia, these consisting exclusively of diactins. This negative result was reached in spite of a special search made in a number of preparations.

Exactly as in *tuberosa*, the hypodermalia in the body proper are mainly diactins; pentactins occur only here and there

amongst them (Pl. IV., fig. 11). They form relatively long and continuous strands of varying strength. Some of the strands, especially those running along or forming the edge of the more prominent wrinkle-like ridges, may be 300  $\mu$  or more in breadth. On the stalk, pentactinic hypodermalia are present in abundance; numbers of them adhere to the finger on being touched.

The canalaria are rough pentactins with or without the knob-like rudiment of a sixth ray. Regular hexactins as canalaria have not been met with.

On other points in the spiculation special remarks may be entirely dispensed with, as they would be but a repetition of what I have already said under typical *C. meyeri*.

### CRATEROMORPHA PACHYACTINA IJ.

Pl. IV., fig. 13.

*Crateromorpha pachyactina*. IJIMA, '98, p. 49.

This species is based on a single and, unfortunately, much injured specimen (Sci. Coll. Mus. No. 395) which is stated to be from the Tosa Sea, off the island of Shikoku. The specimen was found included in the exhibits of the marine products of Kōchi-Ken (Prov. Tosa) in the Fourth Industrial Exhibition held at Kyōto 1895; it was purchased by the natural history dealer "Mimatsu" of Tokyō and subsequently acquired by the Science College. I at first referred it to *Crateromorpha meyeri*, but a closer examination of the structure revealed a number of points which seem to be sufficiently characteristic to found a distinct species on.

The specimen consists of a stalk and a large fragment of the body proper. The former is about 100 mm. long and 18 mm. by 26 mm. thick in the upper portion, but narrower below and just above the swelling at the extreme base. In its general appearance, in the mode of transition into the body proper, in the canal-system traversing the interior and in the ankylosis of principal spicules in the lower portion, the stalk corresponds exactly to that of *C. meyeri*. One thing which attracted my attention from the outset was the fact that on touching it with the fingers it readily gave off sharply pointed and disproportionately strong-rayed spicules (hypodermal pentactins), on which account it was necessary to use extreme caution in handling it.

The fragment left of the body-wall is in a mutilated condition but still sufficiently well preserved for determining the more important features of the sponge. It is easy to conceive that the specimen, when entire, had approximately the size and general appearance of the two specimens of *C. meyeri rugosa* figured in Pl. V., figs. 14 and 15. The external surface is extremely uneven on account of irregular elevations of varying height. The wall is thick, measuring not less than 15 mm. in thickness near its junction with the stalk.

While the gastral surface is perforated with numerous large apertures of excurrent canals and looks much like that of *C. meyeri*, the outer side of the wall presents a remarkably compact and densely felted appearance, apparently due to an excessive development of the parenchymalia as well as to the fact that the dermal layer is closely adherent to the parenchymal mass. The subdermal space is scarcely perceptible, while incurrent apertures and canals, so far as can be recognized with the naked eye, are narrow and widely separated from one another.

The largest incurrent apertures, seen here and there in scattered distribution, do not exceed 2 mm. in diameter.

### Spiculation.

The *parenchymalia* seem to consist exclusively of diactins. Not a single parenchymal hexactin could be discovered although a special search was made for them. A number of the diactins may be called *principalia*. These are straight or bow-shaped spicules of varying strength; smooth all over and sharply pointed at ends. In the body proper they may measure 6 mm. in length and 275  $\mu$  in thickness in the middle; in the stalk they are generally longer but more slender, reaching up to 15 mm. in length and 100  $\mu$  in thickness. The larger diactins are found in especial abundance near the external surface in both the body and the stalk. In the latter they mostly run in longitudinal directions.

But by far the greater part of the *parenchymalia* is made up of very much finer diactins (*accessoria*) generally not over 3 mm. in length with a breadth of only 4–15  $\mu$ . The ends of these are somewhat swollen, rounded and rough-surfaced. These filamentous diactins occur in part as comitalia to the stronger spicules; for the rest they stand alone by themselves and may be developed in such exceedingly great numbers as to form a tissue of very fine soft texture. Such a tissue exists even in the stalk but is confined to the inner portion of its upper part. When freed of any such coarser spicules as may be contained in it, which can be done without much difficulty by feeling for them, the tissue can be balled like wool or cotton by rolling it between the fingers.

The *ankylosis* of certain spicules in the lower part of the stalk occurs in much the same manner as in *C. meyeri*. Perhaps it may be regarded as a point of slight difference that the obsolete microtubercles on the beams of the basal framework are comparatively sparsely present in an irregular distribution.

Strongly developed as are the parenchymal principalia, a far more striking feature is offered by the unusually thick-rayed *hypodermal oxypentactins* (Pl. IV., fig. 13). These occur in abundance on both the body and the stalk. Handling the sponge without due care is liable to lead to the irritating result of finding them impertinently sticking to the skin by their sharp points.

While some of the pentactins—evidently those not yet fully developed—have indeed comparatively slender rays, most of them have rays so thick that they may be said to be nearly of an elongate conical shape. With a length of  $2\frac{3}{4}$  mm. (as measured from the spicular center), the rays may be  $330\ \mu$  thick close to their base. They taper gradually towards the sharply pointed ends and are smooth throughout. All the rays in one and the same pentactin are of nearly equal length. The plane of the paratangentials is usually convex on the outside. The pentactins in situ can be discerned with the naked eye and picked up one by one by means of a pincette. In Pl. IV., fig. 13, a few dermalia and some fine parenchymalia (comitalia) are drawn by the side of a hypodermal pentactin in order to show at once the striking difference in bulk.

No other spicular forms than the above pentactins can be distinguished as hypodermalia. The dermal layer lies in most places in direct apposition to the parenchymal mass, and there-

fore it is scarcely possible to discriminate any one of the underlying diactins as being hypodermal and not parenchymal.

The *dermalia*, so far as I have seen, are all small rough pentactins, exactly comparable to the same of *C. meyeri*. They do not form a distinct dermal lacework, being closely adherent to the tissues below. The *gastralia*, which are likewise rough pentactins, also show no noteworthy point of difference from the same of *C. meyeri*.

The same may further be said of the *hexasters* of this species, so that I need not enter into a description of them beyond making the following cursory remarks.

The *oxyhexaster* is abundantly present in all parts of the parenchyma. Diameter, 80–100  $\mu$ . Number of terminals to each principal, 2–4.

The *microdiscohexaster* is common in the parenchyma generally. Diameter, 38–50  $\mu$ . The figure of this rosette given in Pl. IV., fig. 9, from *C. meyeri tuberosa*, may pass equally well as that of one from the present species.

### CRATEROMORPHA CORRUGATA IJ.

Pl. VI., figs. 1–8.

*Crateromorpha corrugata*. IJIMA, '98, p. 49.

I consider this as a very well characterized species, which, unless the specimen to be identified is too imperfectly preserved, can be easily recognized.



About fifteen specimens in all have passed through my hands. No doubt they all came from the Sagami Sea; a more exact statement of locality can be made only in the cases of five specimens from Outside Okinosé by the Iwado-line (200-300 fms.) and of one from a spot in Dōketsba (100 fms.). The latter specimen, together with *Euplectella marshalli*, *Metacrinus rotundus*, &c., was obtained by Professor MITSUKURI in one of his excursions on the "Golden Hind."

At first sight the species may appear not unlike *C. meyeri tuberosa* or *rugosa* (Pl. VI., fig. 6). The general shape of the body is that of a bowl of irregular contour, broadest at the base, the central portion of which passes below into the stalk. The periphery of the body-base may somewhat overhang the insertion of the stalk.

The external surface of the body proper is very peculiarly characterized. Though it looks much the same as in *C. meyeri* along the thin smooth oscular border, the greater part of it presents a much folded or corrugated appearance. The rounded and quite irregular folds causing this appearance may at once be distinguished from the simple protuberances of *C. meyeri tuberosa* or from the wrinkled irregularities of *C. meyeri rugosa*. Between the folds are furrow-like or pit-like depressions; many of these are shallow and plainly show the cul-de-sac bottom, while others, especially the pit-like ones, are frequently deep and may even be so deep and canal-like that their course can be followed only by introducing probes or by cutting open the wall. And among such deeply penetrating pits or canals there invariably exist some that internally freely intercommunicate with others of the kind. The canals may divide in their course and the branches may by anastomosis form a tunnel-system that opens externally by more

than two openings. Thus the canals in question are strictly comparable in character to the intercanals of the Ascons, and indeed the species bears some external resemblance to certain of those Calcareia. Needless to say the above perforating passages, for which the name intercanal may be borrowed, are throughout lined with the dermal layer as is of course the entire surface externally exposed (*vide* Pl. VI., fig. 7, in which the dermal surface is colored yellow).

The external depressions are on the whole deepest, and the intercanals most frequently developed, in the lower part of the body. In that region the thickness of the body-wall—considering this to be represented by the space between the general surfaces of the exterior and of the central gastral cavity—must be said to be considerable, being 90 mm. or more in very large specimens. But, if we restrict the application of the term “body-wall” to that layer of the sponge-tissue which is bounded externally by the dermal layer and internally by the excurrent surface, irrespective of whether the latter belongs to the gastral cavity or to the canals opening into it, the wall-thickness is nowhere very great, being usually 2–3 mm. and probably never more than 5 mm.

Apart from the external irregularities above described, the dermal surface is smooth. The dermal layer is of an extremely delicate kind. The hypodermal lattice-work is made up of beams which are so fine as to be barely discernible with the naked eye. The closely set incurrent apertures, visible through the dermal layer, are small, measuring not more than 2 mm. in diameter.

The gastral surface (Pl. VI., fig. 7) presents an appearance essentially similar to that of *C. meyeri*. Above and near the oscular margin, there occur only small roundish excurrent aper-

tures, mostly under 2 mm. in diameter. Lower down, larger apertures likewise of roundish or oval shape are added to them until the largest occurring in the deepest part of the cavity may measure 1.5 mm. or more across. Centrally at the bottom there is an irregular space with comparatively small apertures, as we have seen also in *C. meyeri*. The larger apertures usually do not lie very close together but are separated from one another by a rather wide interspace occupied by small apertures only. While the smaller apertures show a sharp angular edge, the larger ones are without any edge at all, the transition of the central gastral cavity into the excurrent passages being gradual and imperceptible. The latter are sometimes shallow and niche-like, at other times much deeper and pit-like or canal-like. The appearance of their wall is essentially that of an extension of the gastral surface. The larger deeply penetrating excurrent canals, as can be determined by cutting them open, often but not always intercommunicate with one another. The anastomosis reminds one strongly of the gastrocanals or the tubar system of the Ascons. It is plainly associated, both genetically and in topographical relation, with the intercanal system of the exterior.

The stalk is nearly as long as, and sometimes perceptibly longer than, the body proper. In general appearance it is scarcely distinguishable from that of *C. meyeri*. It is firm throughout, the lower part being quite hard and compact. The lower end may expand into an attachment disc. Superiorly it gradually broadens, acquiring a densely and longitudinally fibrous appearance and an obtusely polygonal shape in cross-section. On severing the sponge-body, the upper end of the stalk is found to be divided into a few branches; so, at any rate, after the sponge has attained a large size. It is solely by this peculiarity

that I identify the completely macerated stalk shown in Pl. VI., fig. 5, as that of the present species. The branched state is to be accounted for by the intercanal or intercanals that go right through the sponge at the junction of the body with the stalk. The figure just cited will give a good idea of the manner in which the excurrent canals traverse the stalk.

I may now add some remarks concerning certain individual specimens.

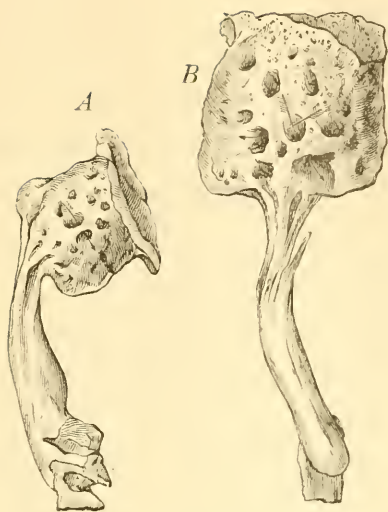
The largest specimen I have seen (O. C. No. 4064) was 320 mm. high, the body measuring fully 250 mm. in greatest breadth.

The typically shaped specimen (O. C. No. 108), shown in Pl. VI., fig. 6, measures 247 mm. in height and 196 mm. in greatest breadth. Stalk, about 90 mm. long. Osculum, 120–140 mm. in diameter. Gastral cavity not deeper than 100 mm. Greatest thickness of body-wall (as measured between two points in the gastral and the general external surface), 90 mm. or more.

Another exquisitely preserved specimen—that depicted in Pl. VI., fig. 7, in a longitudinal section (S. C. M. No. 365, from Outside Okinosé)—is smaller. Total height 116 mm. Breadth at the osculum, 30 mm. Greatest breadth, 74 mm. Stalk, about 60 mm. long and 6–14 mm. broad. Gastral cavity, 40 mm. deep.

An individual with an unusually widely expanded calyx had a breadth of 300 mm. and a height of 250 mm.

Of special interest are the two smallest specimens I have had at my disposal (S. C. M. Nos. 484 & 485, shown in the appended text-figure 2). The smaller of the two (*A*) is about



Text-figure 2.

Two small specimens of *Crateromorpha corrugata* Ls., from Outside Okinose. The arrows indicate the intercommunicating external depressions.  $\frac{2}{3}$  nat. size.

50 mm. high; size of the osculum with out-flaring rim, 26 mm. by 19 mm.; and breadth of the body at base, 23 mm. by 18 mm. The other specimen (B) is 80 mm. high; body, 34 mm. long, and 27–37 mm. broad; size of the oblong osculum, 34 mm. by 16 mm. In both the lateral compression of the body is distinct, a fact which I have not specially noticed in all the larger specimens. Both the small specimens show on the dermal surface of the body a number of dimple-like depressions. Some—

not all—of the deeper and pit-like depressions intercommunicate with one another, representing an early stage in the formation of intercanals. From their general appearance it is to be concluded that the intercanals result from the breaking through of adjacent external depressions, which become deeper as the sponge advances in growth, and apparently not by the fusion of tubular outbulgings from the sponge-wall, although the two processes, as both actually occur among the *Ascons*, are to be considered as modifications of one and the same process leading to the same result. In the two little specimens under consideration, the junction of the body with the stalk is simple exactly as in *C. meyeri*; the piercing through of that part seems to take place at a later stage of the growth of the sponge.



### Spiculation.

The *parenchymalia* do not contain hexactins but consist exclusively of diactins, as in *C. meyeri rugosa*. The diactins are for the most part thin and small, terminating with rough swollen ends; generally under 1.5 mm. in length and 10  $\mu$  in thickness. Occasionally there occur larger diactins which may be called the principalia. These may attain a length of 3 mm. and a breadth of 55  $\mu$  at the middle. They are bow-like or almost straight and differ from the smaller parenchymalia in tapering towards both ends. On account of the general smallness and fineness of the parenchymalia (Pl. VI., fig. 8) the consistency of the sponge-body is soft and delicate, as ascertained on spirit specimens.

The firm stalk, on the other hand, contains parenchymal diactins which may be 10 mm. or more long with a thickness of nearly 80  $\mu$ . In its lower portion is observed the usual synapticular coalescence between the principal supporting spicules. The beams of the rigid framework are nearly smooth all over, the microtubercles being present at places only in a sparse number, much as I have seen them in *C. pachyactina*.

The *hypodermalia* are mainly pentactins, which are supplemented by occasional diactins. The pentactins are small to medium sized, the rays measuring up to 500  $\mu$  in length and 33  $\mu$  in breadth at base. The unpaired proximal ray is somewhat longer than any of the paratangentials in the same spicule. Each ray gradually tapers towards the roughened, usually conically pointed end. The above pentactins exist rather copiously, the spicular centers being separated from one another by an interval which is approximately equal to the length of the para-



tangential rays. With these rays they form a fine hypodermal network, the small meshes of which are irregularly angular or are often incompletely enclosed.—The hypodermal diactins are fine and differ in no way from the smaller parenchymalia. In one specimen of the sponge they were found in tolerable frequency; in others they were rather rare.

The *dermalia* (Pl. VI., figs. 1 & 2) are rough stauractins and pentactins, the former predominating. Length of ray as measured from the spicular center, 85–138  $\mu$ . In certain specimens I have frequently seen the stauractinic forms in possession of the rudiment of the fifth (proximal) ray in the form of a boss (fig. 2). The four paratangentials of a spicule are in a plane which is but slightly convex on the outside and is often nearly perfectly flat. The roughness of the ray surface is, as a general matter, less pronounced than in *C. meyeri*. It often diminishes towards the base of the rays where it is altogether lost (fig. 1).

Along the thin oscular margin the dermalia are found to be represented now and then by tauactins and even by diactins. The latter seem to intergrade with the parenchymalia of the region by forms of intermediate size and character.

The *gastralia* are quite like the dermalia. There occur both stauractins and pentactins amongst them, but their number must be said to be sparse, being found in scattered distribution. A considerable area of the gastral surface may sometimes be searched in vain for gastralia.

No special canalaria have been observed.

The *hexasters* of the species closely agree with those of most other *Crateromorpha*. They are :

Firstly, the oxyhexasters (Pl. VI., fig. 3) which are of quite common occurrence. Diameter, 80–114  $\mu$ . Very rarely I have met with oxyhexasters in which one or two of the principals—never all the six (hexactinose)—bore each a single terminal which was bent at base in the well-known manner. The rule is that the six principals bear each 2 or 3, sometimes 4, diverging terminals. Except at base, these are nearly straight; otherwise they are slightly wavy. Their surface is obsoletely rough or nearly smooth. I have noticed that the principals are, generally at least, perceptibly longer than those in the corresponding rosette of *C. meyeri*. But such finer points in the character of the rosette are probably subject to considerable individual variations.

And secondly, the minute discohexasters (Pl. VI., fig. 4) which have been met with in some numbers—by no means abundantly—in the subdermal space. In no other region of the body have they been discovered. Diameter, 40–50  $\mu$ . The entire shape is quite spherical, all the terminal discs being uniformly distributed on the surface. Under a high power of the microscope the minute terminal disc is seen to be supplied with six, and sometimes more, marginal teeth. The numerous fine terminals arise from all over the convex surface of the disc at the end of each principal, as is usually the case with the so-called microdiscohexaster of the Rossellidæ.

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**HYALASCUS** IJIMA.

Vase-like, firmly attached by contracted base; large. Gastral surface lined with distinct endosomal layer covering over the excurrent canalar apertures. Parenchymalia, diactins only. Hypodermalia, pentactins supplemented with some diactins. Dermalia, generally rough pentactins; occasionally hexactins. Gastralia, similar hexactins. Oxyhexaster represented by hemihexactinose and hexactinose forms. Discohexaster in one small form with very fine terminals.

The genus was originally instituted by me for the reception of a single species which I briefly described in '96 under the name of *H. sagamiensis*. F. E. SCHULZE ('97, p. 525), in his revision of the Asconematidæ, placed this genus and species under that family. For the grounds that have led me to take up the genus under the Rossellidæ, the reader is referred to my Contribution III. ('03, pp. 78-82).

In '98 I referred to the same genus a second species, *H. giganteus*. And now I feel the necessity of establishing a third and new species, *H. similis*.

The genus seems most nearly related to *Scyphidium*, *Vitrolula* and *Crateromorpha*. Its distinction from these as well as from certain other allied genera may be gleaned from the differential key given on p. 18.

The three species, which are all of the genus at present known, will in the sequel be described in detail. They may be distinguished by the following characters:

- a.—Canals narrow, under 2 mm. diameter. Discohexaster, spherical, 80–90  $\mu$  in diameter; usually with only 3, widely divergent terminals to each principal.....*H. sagamiensis* IJ.
- b.—Canals as in the above. Discohexaster, not spherical, 46–50  $\mu$  in diameter; with 12 or more terminals in a separate, outwardly expanding tuft to each principal...*H. similis* IJ.
- c.—Canals may be very wide, reaching several mm. in diameter. Discohexaster, spherical, 30–38  $\mu$  in diameter; with about 10 or less terminals to each principal.....*H. giganteus* IJ.

### HYALASCUS SAGAMIENSIS IJ.

Pl. VII. and Pl. VIII., figs. 1, 2.

*Hyalascus sagamiensis*. IJIMA, '96, p. 251.—F. E. SCHULZE, '97, p. 525.

The species is based on a single specimen (Pl. VII., fig. 1) which belonged to Mr. ALAN OWSTON. After I had studied it, as I understand, the specimen passed into the possession of Prof. B. K. EMERSON of Amherst College, Mass., in which institution it is now probably preserved.

It was stated to have been obtained by some fisherman in the Sagami Sea. Nothing further about the circumstances of the capture is known.

The specimen had been torn off at the inferior end. The wall had also been torn lengthwise right through, but this had been repaired by sewing together the severed edges. Notwithstanding the above defects I believe, especially in view of the shape presented by *H. similis* (text-fig. 3) which so closely resembles the present species that the specific distinctness may almost be doubted, that the specimen had suffered but little change from the original natural shape and that it had been

firmly attached to the substratum by the contracted lower end. In short, the shape of the species seems to be essentially the same as that which I shall later describe for *H. similis* (text-fig. 3, p. 96).

As it was, the specimen (Pl. VII., fig. 1) was vase-like, bulging out on one side at the middle of the upper half, in which part the greatest breadth measured 230 mm. Entire length 500 mm. Shape of cross-section somewhat angular on one side but otherwise rounded. From the broadest part the body narrowed gradually towards the torn off base; superiorly it also showed a slight and gentle contraction before the irregular out-flaring of the oscular region. The osculum, surrounded by a thin, undulating and apparently simple-edged rim, measured 160 mm. across in one direction and 140 mm. in another. Compared with the size of the specimen, the wall must be said to be rather thin. In the broadest part of the body the thickness measured only about 10 mm. and in the lowest part, where the gastral cavity had been opened by the tearing off of the base, about 12 mm.

Both external and internal surfaces are tolerably smooth. The apertures of the canals, incurrent as well as excurrent, are small, all being under 2 mm. in diameter. This doubtless stands in a measure in relation to the fact that the sponge-wall is dense and moderately firm.

The dermal layer of the ectosome is so fine as to be scarcely perceptible with the naked eye. Under the lens its minute meshes appear to be generally quadrate in shape. The hypodermal latticework, just discernible by the unaided eye, comprises irregularly angular meshes not more than 1 mm. in length of sides. Aside from the genuine hypodermal beams there are distinctly observable on the outside a number of much coarser,

long, obliquely running and intersecting strands, which run directly beneath the ectosome. Since this lies close over the choanosomal surface, the said strands may as well be regarded as forming a part of the hypodermal framework as to be considered the most superficially situated parenchymal bundles.

Where the thin ectosome has fallen away, the choanosomal surface appears somewhat roughened on account of numerous shredded ends of very small parenchymal bundles (the pillars), which, coming up from below, terminate just at the ectosomal surface. The little shreds are apparently, at least in part, formed of those parenchymalia which accompany the unpaired proximal ray of hypodermal pentactins.

In the upper part of the gastral cavity the surface, perforated by small excurrent canalar apertures, at places presents simply a coarse felt-like appearance. This is doubtless due to the loss by abrasion of the gastral layer or the endosome which must have once covered the entire gastral surface. At any rate, the deeper and by far the greater part of the cavity is actually lined by a delicate and continuous endosomal layer, through which are seen the excurrent canalar apertures as well as the subgastrally running, long and intersecting strands of the parenchymal mass. At places the surface shows dead-white patches, as if affected by a mould; these are due to excessive local accumulations of gastralial.

### Spiculation.

Pl. VIII., figs. 1 and 2, will serve to give a general idea of the spiculation of the species.



The *parenchymalia* are all slender diactins of variable thickness. Only exceptionally among the thinner ones do there exist such as show an annular swelling in the middle. Their ends are usually sparsely beset with microtubercles and are sometimes pointed and sometimes rounded. The diactins run either isolatedly or combined into long thread-like bundles. In the latter case some of them may, on account of their larger size, be distinguished as the *principalia*. These are long, slender and gently curved or nearly straight oxydiactins, very gradually tapering out towards both fine smooth ends. They may attain a length of 20 mm. or more and a breadth of 120  $\mu$  in the middle. The *comitalia* are only 10  $\mu$  thick or even thinner, showing as usual the same breadth for the greater part of their length. The presence of gradationally intermediate sizes between the *principalia* and the *comitalia* clearly indicates the origin of the former simply by continued growth from amongst the rank of the latter. Synapticular formation exists nowhere, but we should expect to find it in the very base of the sponge which is not preserved.

Along the oscular edge there are seen at some places a palissade-like row of needles, projecting free for about half a millimeter or so; however, it is clear that we have here to do not with special *marginalia* but simply with the ends of ordinary *parenchymalia* unnaturally exposed as the result of abrasion.

The *hypodermalia* (Pl. VII., fig. 6) are, mainly at least, moderately large oxypentactins with smooth tapering rays. The unpaired proximal ray, which is straight, may be 2-3 mm. long. The paratangential rays are shorter, generally measuring 0.9-1.2 mm. in length; they are always curved to a greater or less

degree or somewhat wavy. The pentactins as seen on surface-view preparations are commonly arranged in groups of two or three, the centers lying more or less closely together. The paratangentials in each group, together with those emanating from adjacent groups, are brought together into loose bundles, which constitute the beams of the irregularly meshed hypodermal latticework. Now and then some diactins take part in the formation of the said latticework; they may therefore be regarded as occasional elements of the hypodermalia. Hypogastrally no pentactins occur in the endosome.

The *dermalia* (Pl. VII., figs. 2 & 3; Pl. VIII., fig. 1) are mostly pentactins, not infrequently hexactins and very rarely stauractins. The pentactins are commonly supplied with a boss-like rudiment of the distal sixth ray. The rays are rather strong, measuring 80–110  $\mu$  in length (as measured from the center) and 8–11  $\mu$  in thickness at base. They taper perceptibly from the base towards the conically pointed end (a point, which Pl. VII., fig. 3, fails to show). Their surface is throughout beset with conical and erect or nearly erect microspines that give a coarsely shagreen-like appearance to the entire surface of the spicule. The more prominent microspines may be turned obliquely outwards. Sometimes, but not always, the microspines grow considerably weaker and more sparse towards the base of the rays and the central node. In the hexactinic form the ray that is distally directed is in no way differentiated from the rest. Seen under the microscope the dermal latticework is not in all parts regularly meshed, and where the meshes show an approximately quadrate shape, the paratangentials of separate but

directly adjoining dermalia are, as usual, apposed side by side throughout their entire length.

The *gastralia* (Pl. VII., fig. 4; Pl. VIII., fig. 2) are all hexactins in which the free proximal ray is much longer than any of the other rays. Length of paratangentials, 90-110  $\mu$ . Distal ray as long as paratangentials or somewhat shorter. Length of proximal ray, 185-275  $\mu$ . Breadth at base of rays, 10-14  $\mu$ . All the rays taper very gradually towards the conically pointed ends. (Pl. VII., fig. 4, does not faithfully represent this point. The general shape of the gastralia is better shown in Pl. VIII., fig. 2). Except at the base of rays and on the central node, both of which parts are generally smooth, the surface is beset with numerous microspines similar to those on the dermalia. The microspines on the free proximal ray may be slightly more strongly developed and more distinctly outwardly directed than those on the other rays. In my preliminary description ('96) of the species I have said that the gastralia, on account of their specially developed proximal ray, might be called hexactin-pinules. That statement I beg now to withdraw for fear that it may lead to an over-estimation of the degree of differentiation shown by the proximal ray. The gastral hexactins, it may be said, are no more specially characterized than are those with prolonged proximal rays in certain other Rossellids (f. i., *Staurocalyptus glaber*, *Rhabdocalyptus unguiculatus*, etc.)

*Oxyhexasters* (Pl. VII., figs. 7-10), represented by hemihexactinose and somewhat less frequently by strictly hexactinose forms, are abundantly present in the choanosome as well as in the gastral layer. Normally developed oxyhexasters, in which

all the principals bear two or more terminals each, were not met with; if at all present, they must be exceedingly rare. In diameter or axial length, the oxyhexasters measure 100–145  $\mu$ . Hexactinose forms (axial length 120–145  $\mu$ ) are for the most part appreciably larger than those which are hemihexactinose; indeed this seems to be the general rule with all the Rossellids in which oxyhexasters show a tendency to take the hexactinose form. The terminals appear to be moderately strong, on an average are about  $2\frac{1}{2}$  thick at base, and are generally nearly straight. Their surface is obsoletely rough. The principals are exceedingly short, being almost reduced to nothing. In all cases of the rosettes, if recourse be taken to proper methods of treatment, the axial filament is seen to extend from the spicular center into each principal but never beyond into the terminal, whether this be single or double.

In the hemihexactinose forms, it seems most usual that only one or two, but sometimes three, of the six principals bear two widely divergent terminals on each, the rest of the principals being uniterminal. Thus, oxyhexasters with seven or eight terminal points in all are of the most frequent occurrence. Some with as many as nine terminal points in all have occasionally been met with. A case of a principal bearing more than two terminals has not been observed. This is in unison with the apparently strong tendency of the oxyhexasters towards becoming hemihexactinose or hexactinose, for a biterminal principal may be said to be in a stage which by but one last step in the process of reduction would lead to a uniterminal state. The simple ray composed of a principal and a single ray, whether belonging to a hemihexactinose or to a hexactinose oxyhexaster, is usually nearly straight throughout but may not infrequently show a gentle and

sometimes a more pronounced and somewhat angular bending at base. The latter condition is one which would arise directly from the biterminal state by total atrophy of one of the terminals, while the former condition represents transitional phases of a uniterminal ray towards becoming perfectly straight at base.

Noteworthy seem the degenerate oxyhexasters with less than six terminal points, such cases being certainly quite rare. In Pl. VII., fig. 8, I have shown a case which in view of the shape might be called an oxystauraster. There can be no doubt whatever that this spicule was derived from a hexactinose oxyhexaster by complete suppression of two opposite rays occupying the position of an axis.

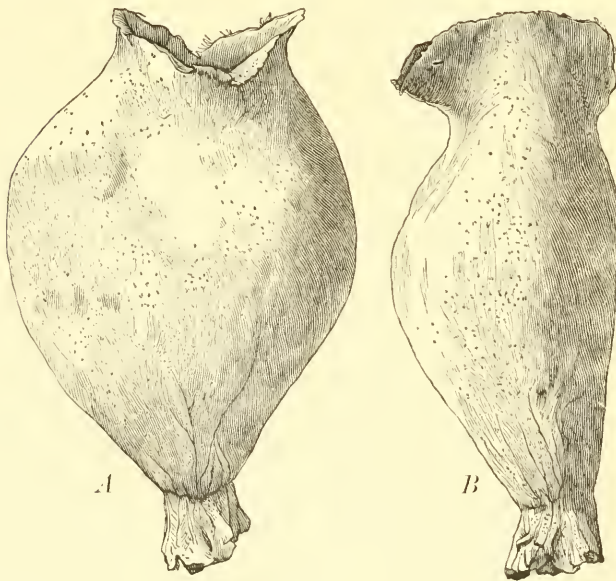
The *discohexaster* (Pl. VII., fig. 5) is moderately common near the gastral surface. It is probably not totally wanting in the parenchyma generally. It is rather small in size, spherical in shape and of an exceedingly delicate nature. Diameter, 80–90  $\mu$ . A spherical central node is sometimes distinctly perceptible and sometimes not. The six principals are short, being only about 3  $\mu$  long; their outer ends seem to be simply truncate, instead of forming a disc-like expansion. The terminals, of which there are usually only three and exceptionally four to each principal, are very fine filaments which thicken somewhat towards the outer end. The small number of the terminals radiating in all directions seems to be characteristic, forming the most important diagnostic feature by which the present species can be distinguished from *Hyalascus similis*. The terminal discs are quite small; in lateral view they appear arched like a watch-glass. Their marginal dentation could not be brought into view. The terminals break off easily at a certain distance from the base, so



that the discohexaster is found but rarely in a perfectly intact state.

### HYALASCUS SIMILIS NOV. SP.

Just in time to admit of the insertion of this description, Mr. ALAN OWSTON has shown me, with his usual courtesy, a beautiful and excellently preserved specimen (O. C. No. 7803) acquired by him not long ago from the coast of the Province of Tōtōmi. It at first appeared to me to be a second specimen of *Hyalascus sagamiensis*, but a close study of the spiculation has led me to think otherwise and I propose to call it *H. similis* n. sp. The exact circumstances of the capture of the specimen are not known.



Text-figure 3.

*Hyalascus similis* n. sp. in  $\frac{1}{5}$  natural size. Two views of the same specimen seen from different directions.

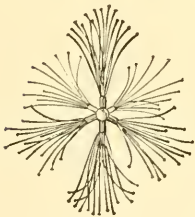
The shape of the specimen is shown in the accompanying text-figure 3 in one-fifth natural size. The saccular and rather thin-walled body measures 380mm. in total height. The main part of it is distinctly laterally compressed. At the



ventricose middle the breadth measures sagittally 230 mm. and transversely 150 mm. The body contracts towards both ends, but less so above than below. The oscular region, which terminates in a thin simple edge, is outflaring to a greater or less degree in different places. The osculum measures 13.5 mm. by 150 mm. in diameter, the lesser and the greater diameter in relation to those of the laterally compressed main part of the body being exactly reversed in orientation. The basal end with irregular longitudinal ribs and furrows measures about 70 mm. across. The surface of attachment to the firm substratum is in several irregularly shaped patches. The wall is only about 5 mm. thick in the middle of the sponge. The gastral cavity extends at the bottom into the stalk-like basal region.

As regards the general appearance of both the external and internal surfaces, the texture and the canals, what I have said under *H. sagamiensis* (pp. 89 & 90) is equally applicable here. The similarity further extends into the spiculation so that this again need not be described in detail except in regard to one point which constitutes the chief, if not the only, distinctive character of the present species.

The point in question concerns the discohexaster (text-figure 4). This occurs not uncommonly in scattered distribution



Text-figure 4.

The discohexaster  
of *H. similis*, 500 ×.

throughout the parenchyma, though by no means so abundantly as the oxyhexasters. Being of very inconspicuous appearance, a careful examination of the preparations is necessary in order to find one. Moreover, the exceedingly fine terminals easily break off, as that it is usual to find the discohexaster in a more or less damaged condition and not infrequently repre-

sented by only the central parts. The size is small, measuring only 46–50  $\mu$  in diameter. The general form can not be said to be spherical, since the terminals to each principal form a distinctly separate tuft shaped like the perianth of a lily. The six principals arising from the small and spherical central node are short; the measurement from end to end of two principals in one axis is scarcely 10  $\mu$ . Their outer ends do not appear to be expanded. The thin terminals (20  $\mu$  long), of which there are 10, 12 or more in a tuft at the end of each principal, are of the most delicate description. They thicken just perceptibly towards the outer end which terminates in a minute pinhead-like disc. The entire ray, with the outwardly expanding tuft of terminals, is in appearance not unlike that of the octaster of certain *Acanthascinae*.

The above discohexaster as compared with that of *H. sagamiensis* presents marked differences. (Compare text-figure 4 [magn. 500 times] with Pl. VII., fig. 5 [magn. 300 times]). It is considerably smaller (46–50  $\mu$  dia. against 80–90  $\mu$  dia.), and the fact that the much more numerous terminals are arranged in distinct tufts gives to the spicule a very characteristic appearance. I think the differences indicated are of sufficient import to justify the specific separation of *H. similis* from the foregoing species.\*

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\* Too late to admit of introducing changes in the text I find that the discohexaster here described is not the only kind but that there is to be ascribed to the species another which I had entirely overlooked. Having occasion to re-examine the preparations, I have come across a discohexaster lying near the gastral surface, which closely resembles that of *H. sagamiensis* (Pl. VII., fig. 5). Spherical in shape, with diameter of 76  $\mu$ . Terminals, 3 or 4 to each short and minute principal; exceedingly fine and very slightly thickened towards the outer end which terminates in a minute disc. Having once seen it, I have succeeded after a prolonged search on several preparations in discovering a few more of the same kind. It must be said that this discohexaster is of very rare occurrence; possibly it is on the verge of disappearance. But then it seems undeniable that we have in it a discohexaster form which is common to both *H. sagamiensis* and *H. similis*. Was not the smaller form (text-fig. 4), considered in the text to be peculiar to the latter species, over-

Of other points in the spiculation I may put down the following notes, though these are in the main nothing but repetitions of what I have already stated under *H. sagamiensis*.

*Farenchymalia*, slender diactins of varying length (up to 25 mm. or more) and thickness (up to about  $175\ \mu$ ); no hexactins. Medium-sized diactins under the gastral layer often with cruciately disposed knobs at the spicular center.

*Hypodermalia*, slender-rayed oxypentactins with bent paratangentials which may be 1 mm. long.

*Dermalia*, pentactins, sometimes hexactins; prickly all over. Length of ray, 80-114  $\mu$ .

*Gastralia*, hexactins in which the free proximal ray may attain a length of 285  $\mu$ ; other rays 120-165  $\mu$  long. Rays prickly but smooth at base.

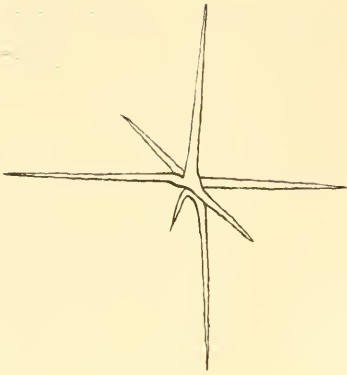
*Oxyhexaster*, hemihexactinose and often hexactinose. Diameter, 90-125  $\mu$ .

All the spicules here remarked upon, let it be repeated, essentially agree with those of *H. sagamiensis* in the manner of their arrangement as well as in details of character.

Finally, I regard it worth while to mention certain oxyhexasters which seemed to be in a state intermediate, so to say, between the hemihexactinose and the hexactinose forms. Such

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looked by me in the specimen of the former? If it was, *H. similis* at once loses its specific status and should be combined with *H. sagamiensis*. However, careful re-examinations of the preparations of the latter, partly newly made from a piece in my possession, have entirely failed to reveal a second discohexaster form in addition to the one attributed to the species in the text. So the matter stands thus: *H. sagamiensis* has a single discohexaster form; *H. similis* possesses the same in quite a limited number and, in addition to it, a second smaller form which occurs in moderate abundance. Whether with more specimens in hand the difference indicated can be maintained as a specific distinction, can not be foretold. Since anyway it seems impossible to base generic separation on that difference, it becomes necessary to make a slight emendation in the generic diagnosis given on p. 87, the last sentence on which should read "Discohexasters in one or two small forms with very fine terminals," instead of "Discohexasters in one small form", &c.



Text-figure 5.

An oxyhexaster in the last stage of becoming hexactinose. 440  $\times$ .

cases were incidentally met with more than once in the present species. The accompanying text-figure 5 shows one of them. Five of the rays are simple, being either straight or bent at base, exactly like those in hexactinose forms of the oxyhexaster; in them the principals are strictly uniterminal. The sixth of the principals, which are all of quite an obsolete length, bears, besides a normally developed terminal, another of spurious size.

Were this as much developed as its fellow on the same principal, we should have a normally hemihexactinose form in which a single principal is biterminal and all the other five are uniterminal. On the other hand, if it should altogether disappear, as it apparently is on the verge of doing, the result would be a hexactinose form, the exact like of which may not be difficult to find among the oxyhexasters of the species. In my experience certain other Rossellids have also yielded similar cases of oxyhexasters being in the last stage of transition into the hexactinose state.

### HYALASCUS GIGANTEUS IJ.

Pl. VIII., figs. 3-16.

*Hyalascus giganteus*, IJIMA, '98, p. 50,

This species is described on the basis of a large fragment which originally belonged to Mr. ALAN OWSTON (O. C. No.

4063) and is now to be seen in the British Museum. It came from the Sagami Sea, the more exact locality being unknown.

The thick plate-like fragment is nearly as large as the blade of a tennis racket. Greatest length, 480 mm. Greatest breadth, 255 mm. Thickness, 45 mm. It is torn all around, had evidently been flattened out during desiccation and does not warrant inference as to the shape and size of the original sponge except that it must have formed part of the wall of a very large and presumably vase-like individual. The piece, being preserved in the dry state, is light and of a cavernous appearance on account of broad incurrent and excurrent canals. The spongy septa between the two canal systems are rather thick. The incurrent canals, which in places may be 15 mm. wide, seem to freely anastomose with their branches, thus forming a continuous system extending throughout the whole specimen, while the excurrent canals only occasionally intercommunicate with the branches and more usually remain separate from one another.

The dermal surface (Pl. VIII., fig. 3) is much macerated, so that its exact nature is difficult to determine. Here and there the apertures of incurrent canals appear as oval or roundish openings of not over 10 mm. diameter. Not that they are all freely open, but a large number of them are seen to be covered over with an uneven and irregularly cobweb-like layer formed of spicular bundles which intersect, unite and branch in quite an indefinite manner. The thicker bundles may show in places a thickness of over 1 mm. Between the canalar apertures the said layer is indistinguishable from the tissue of the parenchymal septa. It is not to be doubted that the layer constitutes the hypodermal framework. The dermal layer proper remains in small patches only in a few places. Even if it were extensively



preserved, I should think it would be rather inconspicuous because it closely overlies the choanosomal surface in parts and the cobweb-like hypodermal framework in other parts.

Some deep and chasm-like slits occur on the external surface, their wall presenting a granular appearance. This is due to broken ends of the parenchymalia which there appear to be evenly nipped off. The slits were evidently made by Ophiurons which took their abode in the sponge, as is apparent from such as still contain that animal.

The gastral surface (Pl. VIII., fig. 4) is in a much better state of preservation. The excurrent canalar apertures, of very various sizes under 18 mm. diameter, are covered over with an endosomal latticework composed mainly of moderately strong and compact strands which may be called hypogastralia. The meshes are angular but irregular in shape, mostly measuring 1-3 mm. in length of sides. They are all open, which I believe is the natural state. At any rate, the gastralia proper are only found either distributed singly on the beams, or several together on the nodes, of the hypogastral latticework.

Remarkable is the fact that under certain circumstances the above endosomal latticework, instead of extending merely in a plane layer, may be developed more or less in the third dimension also so as to form a trabecular system of some thickness. Thus, I have seen some cases of the excurrent canalar apertures being incompletely closed, so to say, by a spongy partition.

The larger the excurrent aperture, the deeper is the pit-like canal it leads into. Usually about half-way through the sponge-wall, the larger canals begin to divide up into branches. And these branches, unless they happen to be small, are seen to begin with apertures which are spanned by essentially the same lattice-



work as that guarding the entrance into the main canal on the gastral surface. In other words, the lining layer of the gastral cavity is duplicated on the wall of the main passage of excurrent canals. But this duplication does not occur in all the smaller canals.

It must be said that in respect of the wall-structure macroscopically considered, the sponge shows a rather wide deviation from both *H. sagamiensis* and *H. similis*. Nevertheless, there exist several points of close resemblance in spiculation, a fact which mainly weighed with me in referring the species to the same genus. The species is probably very nearly related to *Crateromorpha*; but I was deterred from placing it under that genus solely by the presence of hexactins among the dermalia and of a covering latticework to excurrent canalar apertures and by the fact that the gastralia are all hexactins.

### Spiculation.

The *parenchymalia* are exclusively slender diactins of widely varying sizes. The largest, the *principalia*, may reach 23 mm. in length and 175  $\mu$  in breadth at the middle, while the finest are of the ordinary dimensions of a *comitalia* only about 7  $\mu$  thick. They are in general irregularly bent or wavy, either gradually tapering out to a point at both ends or terminating with conical or rounded tips. Subterminally the surface seems to be always rough on account of microtubercles that are sometimes wart-like and sometimes spine-like. As a rule there exists not the slightest trace of an external swelling marking the spicular center.

Both the *hypodermal* and *hypogastral* beams (Pl. VIII.,

figs. 5, 6), giving support to the ectosome and the endosome respectively, consist in the main of bundles of diactins, either loose or compact, which are comparable to the smaller parenchymalia. Among themselves the hypodermal and hypogastral diactins are of various sizes, with thickness reaching up to  $30\ \mu$ . The shorter ones amongst them usually show a gentle annular swelling around the spicular center. Hypogastrally there not infrequently occur diactins as short as, or at any rate not much longer than, the axial length of the gastral hexactins, like which spicules such short diactins may have microtubercles sprinkled nearly all over the surface. Their appearance is such that they might have arisen directly from the gastralialia by loss of the four rays in two axes.

Hypodermal pentactins were discovered only in a limited number. There can scarcely be a doubt as to their being clearly distinguishable from the dermalia, though under certain circumstances they seem to closely approach these both in size and appearance. In them the unpaired proximal ray is the longest of all the five rays; it may be more than twice as long as the paratangential. The latter, in one case measured, was  $700\ \mu$  long and in another case, considerably over that; but it may sometimes be as short as  $300\ \mu$ . In short the size is subject to considerable variation. The paratangentials are rough nearly throughout their entire length, the roughness being quite similar to that of the dermalia, while the proximal ray is generally smooth except towards the end.

The *dermalia* are predominantly pentactins (Pl. VIII., fig. 3) with a sixth ray represented by a small hillock-like prominence on the distal side. In these the unpaired proximal ray is

usually somewhat shorter than the paratangentials. Not infrequently the proximal ray is also reduced to a knob-like rudiment, so that the spicule takes the form of a stauractin (Pl. VIII., fig. 9). On the other hand, the distal knob of the pentactins is sometimes prolonged in varying degrees, leading to the regular hexactinic form which is in fact occasionally met with. In all cases the rays are rather slender, tapering but slightly outwards and terminating with rounded or subconical tips; the roughness of surface, caused by rather unprominent microtubercles, is most pronounced in the outer half of the rays and becomes gradually weaker and inconspicuous towards the base. In size the dermalia show a somewhat wide range of variation. As measured on the paratangentials, the ray-length (half-axis) measures 120–200  $\mu$  with a breadth of about  $7\frac{1}{2}$   $\mu$  at base. The plane of the four paratangentials in a pentactinic dermalia is flat or just perceptibly arched. In some parts of the sponge surface, I have seen the dermalia form a regularly quadrate-meshed lacework in which the meshes measured on an average 110  $\mu$  in length of sides. In other places they are evidently quite irregular in the mutual relation of their paratangential rays.

The *gastralia* (Pl. VIII., fig. 7) are similar but on the whole much larger hexactins. The length of rays, as measured from the spicular center, is mostly 165–385  $\mu$ . In the largest of the spicules, the breadth of rays at base may reach 20  $\mu$ . The six rays are often unequally long, but I could not deduce the rule that the free proximal ray is the longest. It is only occasionally that a number of the gastralia are found so grouped as to form approximately quadrate meshes with their paratangentials. The distribution is for the most part quite irregular. As before men-

tioned, a continuous autogastral layer covering up the meshes of the hypogastral framework seems not to exist. Perhaps worth noting is the fact that the paratangentials are frequently observed running among or under, instead of over, the diactinic elements of the hypogastral beams.

Hexactins similar to the gastralial occur in some number as *canalaria* on the beams of the lattice-like layer lining the lumen of the larger excurrent canals.

Of the hexasters, *oxyhexasters* (Pl. VIII., figs. 12-16) occur in abundance in the choanosome. Diameter or axial length, 80-125  $\mu$ . They are mostly hexactinose and less frequently hemihexactinose. In the latter case, one to three of the six, extremely short or nearly entirely atrophied principals bear each two widely diverging terminals. In fact, three seems to be the utmost number of principals that may be biterminal in an oxyhexaster. At any rate, normally developed oxyhexasters, i. e., those in which all the six principals bear more than one terminal each, were on no occasion met with. The uniterminal rays, i. e., those consisting of a principal continued into a single terminal, whether belonging to a hexactinose or to a hemihexactinose oxyhexaster, are either bent at base or are straight or nearly straight from the origin at the central node. Pl. VIII., fig. 16, represents a rare case of a hemihexactinose oxyhexaster with peculiarly bent rays. Now and then there are observed cases of a principal bearing a terminal of normal length and in addition the short rudiment of a second. Pl. VIII., fig. 14, is an example of such cases; and text-figure 5, on p. 100, may well pass for one taken from the present species. Occasionally a principal together with its terminal seems to be totally suppressed in development; only

in this way can be explained such oxyhexaster forms as are shown in Pl. VIII., figs. 12 and 13, or those I have seen in which less than six (e. g., only four) rays in all emanated from the central node.

In all the oxyhexasters the terminals are rough-surfaced. The roughness is frequently seen to be caused by minute retroverted tubercles.

The precise extent of the short axial filaments forming the central cross can be clearly observed if one goes through the necessary steps of preparation. It needs simply to be stated that Pl. XIV., figs. 24 and 25, may be said to represent exactly the state of things in the central part of oxyhexasters of the present species.

The *discohexasters* (Pl. VIII., figs. 10 & 11) are common in both the choanosome and the gastral layer. At places they are much more numerous than the oxyhexasters. They occur in one small and delicate form of spherical shape, measuring only 30-38  $\mu$  in diameter. Each short principal bears sometimes about 10, and sometimes only about 6, very slender terminals ending in a comparatively large disc with about half a dozen, slender, marginal teeth.

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### AULOSACCUS IJIMA.

*Aulosaccus*, Ijima, '96.

*Calycosaccus*, F. E. SCHULZE, '99.

Vase-like, thick-walled, firmly attached at base; moderately large. Gastral surface lined with a conti-

nuous endosomal layer. Parenchymalia, of diactins only. Without pentactinic hypodermalia. Dermalia, various according to species. Gastralia, rough hexactins. Oxyhexasters show a greater or less tendency to occur in hemihexactinose and hexactinose forms. Discohexasters in two spherical or approximately spherical forms: macrodiscohexaster and microdiscohexaster. The former with numerous terminals and usually strikingly large in size.

The above diagnosis is drawn up regarding the genus, as it now stands, as made up of the three following species:

1. *A. schulzei* IJ.
2. *A. ijimai* (F. E. SCH.) = *Calycosaccus ijimai* F. E. SCH.
3. *A. mitsukurii* IJ.

The first and the last mentioned species, which were years ago described by me in brief, will be treated of in full in this Contribution.

The second mentioned species is one which was described by F. E. SCHULZE ('99), who made of it a special genus, *Calycosaccus*. He was certainly fully cognizant of the close similarity of his genus and species to my *Aulosaccus schulzei*, so much so that, as he clearly implies (*l. c.*, p. 100), he would not have hesitated to associate the two forms in the same genus, had it not been for a difference in the character of their dermalia. That difference was the one on which he based the distinction between the families Asconematidæ and Rossellidæ. His species had to be placed under the Asconematidæ, while *Aulosaccus* was to be considered a Rossellid. From such a position, it of course followed that the species must receive a generic designation of its own. Now, in



my Contribution III., pp. 78-83, I have endeavored to show that the Asconematidæ had better be dissolved and that a number of its genera, *Calycosaccus* for one, should be taken over by the Rossellidæ. If I am right in so doing, *Calycosaccus* as a name for a Rossellid genus seems to lose its claim for existence, as was indeed anticipated by F. E. SCHULZE himself. Nothing more than a specific value can be attached to the difference between *C. ijimai* and *A. schulzei*.

It is with a much less degree of certainty that I refer *A. mitsukurii* to the genus. It differs decidedly from both *A. schulzei* and *A. ijimai* in the possession of strong preoral needles and in the comparatively small size of its macrodiscohexaster. That these differences sufficiently warrant generic distinction seems to me to be doubtful, so that the species may best be left for the present in the genus to which it was originally assigned.

*Aulosaccus* shows greatest affinity to *Scyphidium* and *Rossella* in that it possesses like these the two kinds of discohexasters, but differs from both in having no pentactinic hypodermalia. This negative character is also shared by *Aulochone* under the Rossellinæ, but that genus lacks the macrodiscohexaster. If *A. mitsukurii* were only provided with pentactinic hypodermalia, I should have no hesitation in referring it to *Scyphidium* and placing it by the side of *S. longispina*, which species it most closely resembles in the rest of its characters.

The three species of the genus may be distinguished as follows :

a.—Without conuli and needle-like preoralia.

a'.—Dermalia, hexactins or predominantly hexactins. Macrodiscohexaster may measure 400  $\mu$  in diameter; its principals separate or represented by six hemispherical bosses..... *Aulosaccus ijimai* (F. E. SCH.).

- b*<sup>1</sup>.—Dermalia, pentactins or predominantly pentactins. Macrodiscohexaster may measure nearly 1 mm. in diameter; its principals fused into a spherical mass.....*Aulosaccus schulzei* IJ.  
*b*.—With comuli, from the apex of which project needle-like prostalia.  
*c*<sup>1</sup>.—Dermalia, predominantly stauractins. Macrodiscohexaster not over 120  $\mu$  in diameter; its principals separate ..... *Aulosaccus mitsukurii* IJ.

### AULOSACCUS SCHULZEI IJ.

Pl. VIII., figs. 26–28, and Pl. IX.

*Aulosaccus Schulzei*, Ijima, '96, p. 252.

In Mr. Owston's collection there existed a single specimen from which I have described this genus and species. It subsequently passed, together with the type specimen of *Hyalascus sagamiensis*, into the possession of Prof. B. K. EMERSON of Amherst College, Mass. A second specimen of the species has never been obtained.

The type specimen (Pl. IX., fig. 1) was procured by Mr. Owston by purchase from a fisherman of the village Koshigoe, near Enoshima, and there could be no doubt of its having been taken from the Sagami Sea.

It is exquisitely vase-like, being broadest in the upper third of its length and gradually narrowed below. The basal end is cut off and not preserved. Total length of the specimen, 450 mm. Greatest breadth, about 225 mm. Superiorly from the broadest part the wall more or less curves in to terminate with a thin oscular margin, which is much injured and may have been in part somewhat out-flaring. The osculum is irregularly circular with a diameter of approximately 150 mm. Thickness of wall in the middle of the upper half, 25 mm.; same in the middle of the lower half, 39 mm. The lower or severed end is somewhat

oval in section, measuring about 110 mm. across. Here the wall is 35–50 mm. thick, the gastral cavity opening by an elongate aperture of 35 mm. by 20 mm.

The greater part of the dermal skeleton has fallen off. Where it is preserved it shows an exceedingly delicate dermal layer supported below by fine hypodermal strands that intersect one another at various angles (Pl. VIII., fig. 26). The latticework of the former is scarcely perceptible with the naked eye; the latter form irregular meshes of various sizes, generally under 2 mm. in length of a side. The dermal skeleton must have given a tolerably smooth surface to the sponge. It easily breaks off in flakes in the dried state. The subdermal space seems to be of an inconsiderable width.

The parenchymal mass, exposed on the outside by abrasion, presents a curly appearance, not unlike that of a wiry fur. The apertures to incurrent canals are medium-sized or smaller.

The gastral surface is very well preserved. It is lined all over with a continuous layer of the delicate endosomal skeleton. This consists of a small (generally 1–1½ mm.) and irregularly meshed latticework of thin hypogastral strands bearing the gastralia which, without forming a continuous layer by themselves, leave the hypogastral meshes more or less freely open. Seen under the lens, the gastralia are arranged for the most part in a row on the hypogastral strands with their paratangentials standing out free at right angles on both sides of the latter, though here and there several of them may lie side by side so as to form with their paratangentials small irregular patches of a quadrate-meshed latticework. Taken altogether the arrangement of the gastral skeleton resembles that in *Acanthascus cactus* as shown in Pl. XI., fig. 16, though it is more delicate. It

forms a sieve-like layer covering over the entrances into the ex-current canals.

### Spiculation.

The *parenchymalia* are all slender diactins in loose felt-like arrangement or grouped together into thin ill-defined bundles. The *principalia* may attain a length of 17 mm. or more and a breadth of 100  $\mu$  at the middle; they taper gradually towards both the smooth and sharply pointed ends. There exist all sizes down to *comitalia* only 8  $\mu$  in thickness. All the smaller diactins have rough ends, which may be tapering but are more usually slightly swollen and terminating in a conical or rounded tip. In all the *parenchymalia* the spicular center is externally evenly contoured.

The *hypodermalia* and *hypogastralia* are both likewise diactins, generally 15–20  $\mu$  in breadth and under  $3\frac{1}{2}$  mm. in length. They quite agree in appearance with similarly sized *parenchymalia*, except in the fact that the spicular center is often, but not always, externally marked by an inconspicuous annular swelling. They are generally arranged into thin strands of varying strength. The manner in which these strands make up the hypodermal and hypogastral latticework has already been dwelt upon. No pentactins enter into their composition.

The *dermalia* (Pl. VIII., fig. 26; Pl. IX., fig. 12) are predominantly pentactins in which the place of the atrophied sixth ray is generally indicated by a gentle swelling on the distal side of the piratangential cross. Exceptionally they are represented by stauractinic forms, in which the two aborted rays in the radial

axis are either quite obliterated or represented by vestiges in the form of an external and an internal knob. The rays, as measured from the spicular center, are 100–250  $\mu$  (on an average 130  $\mu$ ) long and  $7\frac{1}{2}$ – $9\frac{1}{2}$   $\mu$  broad at base. For the greater part of their length they maintain a nearly uniform thickness. Their surface is entirely rough, the roughness being most pronounced near the outer conically pointed end.

The meshes of the dermal latticework are tolerably regularly quadrate, measuring on an average 140  $\mu$  in length of sides.

The *gastralia* (Pl. VIII., fig. 27 ; Pl. IX., fig. 11) are rough hexactins, rarely pentactins and still more rarely stauractins, of much greater dimensions than the dermalia. The paratangentials mostly measure 200–275  $\mu$  in length and 10–15  $\mu$  in thickness at base. The distal ray is nearly as long as, or somewhat shorter than, the paratangential in the same spicule, while the proximal ray is generally longer than the same and may be 385  $\mu$  in length. The rays taper perceptibly towards the conically pointed end ; their entire surface is nearly uniformly rough. The manner of arrangement of the gastralia over the hypogastral beams in completing the endosomal skeleton has already been referred to.

Of the hexasters, the *oxyhexaster* (Pl. IX., fig. 2–7) is of frequent occurrence among the parenchymalia. As in *Hyalascus* it is present in either hemihexactinose or hexactinose forms but probably never in the completely hexasterous. Axial length or diameter, 100–150  $\mu$ . The terminals which look moderately strong are about 3  $\mu$  thick at base, and are obsoletely rough on the surface.

In the hemihaxactinose form (fig. 6) it is only one or at most two of the exceedingly short principals that bear two widely divergent terminals. A case of more than two terminals to a principal has not been met with.

The hexactinose form (fig. 2) is as common as, if not more common than, the hemihexactinose. Uniterminal rays, whether occurring in this or in the other form, are usually straight but may sometimes be bent at base. One case that I observed of a straight rayed hexactinose hexaster, in which two of the rays bore each a small spine-like rudiment of an obsolescent terminal, seems to be worthy of special note.

In this species again it is a readily noticeable fact that the largest of the oxyhexasters are found among those of the hexactinose variety.

Exceptionally certain principals totally disappear together with the terminals belonging to them. Thus arise peculiar degenerate forms which under certain circumstances may have less than six terminal points in all (figs. 4, 5 and 7). Fig. 4 is evidently a case in which one entire axis is quite suppressed, there remaining three uniterminal principals and a single biterminal one, all lying in one plane. In fig. 5 there are seen six rays, but all these again lie in one plane; they represent either three biterminal principals or four principals of which two are biterminal and the rest uniterminal. Fig. 7 is an extreme case of the reduction; there are left only three rays, assumably representing as many half-axes each composed of a principal continued into a single terminal.

The most characteristic spicule of the species is the *macrodiscohexaster* (Pl. VIII., fig. 27; Pl. IX., fig. 8). This is strik-



ingly large and of a shape which may be called sun-like. From a central spherical mass there arise like rays from all over its surface numerous very long and slender terminals. This most remarkable rosette is of moderately common occurrence in the choanosome and can easily be recognized under the hand-lens as it lies on or among the extracted parenchymalia, appearing like a whitish fleck. The terminals always appear to have been more or less disturbed in their positions; they often stick together and form indefinite bundles (Pl. VIII., fig. 27), apparently as the result of mechanical strains upon their flexibility. If left perfectly undisturbed, we may assume that they would radiate uniformly in all directions, thus giving an approximately spherical shape to the entire spicule. The diameter should then measure nearly or quite 1 mm., a size which may be said to be gigantic for a hexaster. As first sight one may be inclined to take the spicule for some object other than a hexaster. Nevertheless, there can be no doubt whatever as to its hexaster-nature.

The central sphere (Pl. VIII., fig. 28) measures 46–49  $\mu$  in diameter. The surface is not even but shows some irregularity in contour; however, this does not in the slightest degree indicate the convexity of the terminal surface of the six principals. These, together with the original central node, seem to be completely imbedded in the sphere. In other words, apparently a secondary deposition of siliceous matter has taken place between and over the principals so as to fill up the interspaces between them, also covering them up on the external surface between the bases of the terminals. To become convinced of this point it is necessary to examine the spicule in glycerine after it has been thoroughly cleansed by boiling in acid. Under a high power of the microscope, the six-armed cross of axial threads is then

detectable with unmistakable distinctness in the central sphere, as depicted in Pl. VIII., fig. 28. The periphery of the sphere appears compact, while more centrally in the neighborhood of the axial threads are visible a number of small and irregularly shaped vacuoles which appear like dark granules. These vacuoles I consider to be the same as those which are so commonly seen, often arranged in rows, in the eight principal arms of Acanthascine discoctasters (*cf.*, f. i., Pl. XII., fig. 27 ; Pl. XV., fig. 9). They are in all probability spaces which remain unfilled by the siliceous substance during the amalgamation process of spicular parts originally separate, and are in that sense comparable to the mesh-like spaces inclosed between synapticulæ that solder together parenchymalia. I am therefore strongly inclined to believe that the state of things in the macrodiscohexaster of the present species is brought about by the formation of synapticular connections between the principals, and not by simple fusion of their surfaces after coming into direct contact nor by their total disappearance in which case the central sphere would be identical with the central node of ordinary hexasters, which does not appear to be really the case.

The appearance of the surface of the central sphere as seen by focussing up and down the microscope, strongly reminds one of that of a Foraminifera shell. The points of origin of the numerous terminals are thickly and uniformly distributed all over the surface (Pl. VIII., fig. 28).

The terminals are filament-like and quite obsoletely rough-surfaced. The minute prominences causing the roughness have their points directed backwards (Pl. IX., fig. 9). The terminals thicken just perceptibly towards the outer end, where the breadth measures only about 2  $\mu$ . The length is quite various, fluctuat-

ing between  $95\ \mu$  and  $475\ \mu$  in the same rosette. I thought it possible that the terminals formed six bunches corresponding to the six original principals and that in each bunch the longer terminals occupied a more central position than the shorter; but this could not be verified. On the contrary, those of different lengths seemed to be situated together promiscuously.

The terminal disc (Pl. IX., fig. 9) is somewhat conically convex on the outer side. It measures about  $10\ \mu$  in diameter. The margin shows a row of numerous small teeth.

The *microdiscohexaster* (Pl. IX., fig. 10) of a very delicate nature is common in the choanosome as well as in the endosome. In some places in the former it occurs almost as numerous as the oxyhexaster. Diameter,  $26\text{--}38\ \mu$ .

The shape is spherical, the minute granule-like terminal discs however do not lie on an even level at the surface. The terminals are so exceedingly fine that they can scarcely be perceived unless a very high power of the microscope be used for the observation. The principals are slender and form a cross measuring about  $7\frac{1}{2}\ \mu$  in axial length. Their outer ends do not show a disc-like expansion, nor is the central node spherically swollen.

### AULOSACCUS MITSUKURII IJ.

Pl. X., figs. 1-15.

*Aulosaccus mitsukurii*, IJIMA, '98, p. 52.

A single specimen belonging to the Sci. Coll. Museum formed the type of this species at the time it was first described by me

in '98. Subsequently I have had the good fortune to discover a second specimen in Mr. OWSTON's collection.

The original type-specimen (S. C. M. No. 427) was obtained by KUMA at a spot, about 572 m. (=313 fms.) deep, on Inside Okinosé by the Sengenzuka-line (W. of Dōketsu). It is shown in half natural size in Pl. X., fig. 1. In shape and other general characters it so closely simulates *Acanthascus cactus* that the specimen long remained among the duplicate specimens of that Hexactinellid until I chanced to examine it microscopically and thus became aware of its remarkable differences in spiculation. Since then I have subjected all my *Acanthascus* material to a microscopical test in order to see if the determination was correct.

The specimen is an elongate, moderately thick-walled sac with several broad and irregular processes in the lower part. One of these processes, which stands out most prominently to one side, is to be considered in the light of a bud; for, it opens at the rounded end an independent osculum leading into a gastral cavity which is widely separate from that of the mother person. The other processes clasp the branched skeleton of an *Isis* on which the specimen grows. The coral branches also pass through a thickened part on one side of the lateral wall. Height of body, 147 mm. Breadth at the middle, about 56 mm. Thickness of wall in that part, 9 mm.; thicker lower down the body. The main osculum at the upper end is irregularly roundish, measuring 33–40 mm. in diameter; its margin is simple and sharp-edged. It leads into a deep gastral cavity which widens somewhat at the bottom and is continued obliquely below into a tubular passage that finally opens outside by a small secondary osculum situated on a gentle swelling near the lower end.

A conspicuous feature of the species is presented by a num-

ber of broad-based conical prominences, the conuli, that rise from the external surface. These are most prominent in the middle part of the body, reaching 10 mm. or more in height as measured from the depressed surface between them. Their apices are generally 10–30 mm. apart from one another. Their appearance reminds one at once of the conuli of *Acanthascus cactus*. The resemblance is all the greater since they bear on the apices thin prostal needles directed either straight outwards or obliquely upwards. Usually a single prostal occurs on each conulus, but there are sometimes more than one. It may project to a length of 15 mm. In the immediate neighborhood of the oscular margin there exist some upwardly directed prostals that arise without a conical elevation of the wall at their base.

Strikingly similar as is the general external appearance between this species and *Acanthascus cactus*, a close comparison reveals certain points of difference in the structure of the ectosomal skeleton,—differences, which, under certain circumstances, might suffice to distinguish the two species upon superficial observation alone. In the first place, the delicate dermal lacework of the present species allows the meshes, minute though they are, to be perceived without difficulty with the naked eye, while for *A. cactus* the same can hardly be said. This is owing to the difference in the thickness of the rays of their dermalia. In the next place, the supporting hypodermal strands are considerably fewer. They intersect one another at various angles and form triangular, trapezoidal or irregular meshes, the sides of which not infrequently measure 4 mm. or more in length. Whereas, the same meshes in *A. cactus* (Pl. XI., fig. 17) rarely, if ever, exceed  $1\frac{1}{2}$  mm. In short, the hypodermal framework of the pre-



sent species incloses much wider meshes, which fact imparts a more delicate appearance to the entire ectosome.

The hypodermal strands on the conuli are seen to converge towards the apex. The extreme apex is generally compact-looking, owing to the crowded presence there of the dermalia. The same may be said of the dermal surface at, or close to, the oscular margin.

The subdermal space in the greater part of the sponge is moderately wide. Strands of spicules pass up across it, at frequent intervals, from the exceedingly uneven choanosomal surface to join the hypodermal framework.

Through the thin ectosome are plainly visible the numerous incurrent canalar apertures, 3 mm. and under in diameter.

A thin and delicate endosomal layer lines the entire gastral surface. The gastralia form a continuous lacework with quadrate meshes which are considerably larger than those of the dermal layer. The layer appears as if sprinkled with white powder, owing to accumulations of microscleræ. To the naked eye, the presence of hypogastral strands is in most places not apparent; but where the gastralia are sparse and scattered or when seen under the microscope on preparations of the endosome, the hypogastralia appear to form a thin-beamed and comparatively wide-meshed latticework similar to the hypodermal. In *Acanthascus cactus* the hypogastral beams (see Pl. XI., fig. 16) are somewhat coarser and inclose smaller meshes which moreover open free instead of being covered over by a continuous gastral lacework. Here then is another point which might serve in distinguishing between that and the present species.

The excurrent canalar apertures are all small in the upper part of the gastral cavity. Lower down, larger ones add them-



selves and in the deep part of the cavity there are some that reach 6 mm. in diameter.

The second specimen (O. C. No. 4399) I have seen of the species was from an unknown locality in the Sagami Sea. It was collapsed and incomplete, lacking the basal part. Length, 225 mm. Greatest breadth, 130 mm. Average thickness of wall, 16 mm. The piece must have originally formed a great part of a large individual. The one end still preserved a section of the oscular margin; the state of the parenchymalia at the other end indicated proximity to the basal attachment. The external surface was badly lacerated but still showed traces of the conuli. The prostalia had all been lost. Some of the canalar apertures on that side were as much as 5 mm. in width. The endosomal skeleton remained in good preservation, covering over the excurrent canalar apertures.

### Spiculation.

Pl. X., fig. 11, represents in a general way the spiculation as observed on a section of the sponge-wall.

The *parenchymalia* are all diactins which are generally smooth throughout except subterminally for a short space where the surface is roughened in the well-known manner. Of rather common occurrence are the strong principalia which may attain a length of 20 mm. and a thickness of nearly  $\frac{3}{4}$  mm. at the middle. These have gradually tapering and acuminate rays and are therefore to be called oxydiactins. They are bent in a bow-like manner but are otherwise nearly straight. The rest and by far the greater number of the *parenchymalia* are more slender spicules, there existing all sizes transitional between the strongest

principalia and the shortest and finest comitalia. Those of the smaller dimension usually have the tips of the rays rounded or somewhat conically shaped. As usual the diactins run either solitarily or in loose bundles of indefinite strength. The parenchymal fibers may be said to be somewhat coarse; decidedly so are they in the larger specimen belonging to Mr. Owston, especially in its lower part.

The *prostalia* are diactins of moderately large size. It would not be improper to regard them simply as certain parenchymalia that had protruded themselves to a greater or less extent from the apices of conuli (Pl. X., fig. 11). Their outer ends are generally broken off.

The *hypodermalia* are likewise diactins, exactly similar in character to the smaller parenchymalia. One large hypodermal diactin measured was 2 mm. long and 27  $\mu$  thick at the middle. In forming the hypodermal beams, the diactins run sometimes singly and at other times combined into bundles in variable number.

The *hypogastralia* again are diactins which for the most part are exactly comparable in all respects to the hypodermalia or to the smaller parenchymalia. However, one feature peculiar to many of them, but not to all, consists in the fact that the spicular center is externally marked by an annular swelling or by four cruciately disposed bosses,—a feature which is but rarely, if at all, noticeable on either hypodermal or parenchymal diactins. Precisely the same fact has been noticed by me in certain other Rosselline species. Further, among the hypogastralia with the

above markings, not a few are comparatively short in proportion to their breadth and present an elongate spindle-like shape. These, like all other diactins of the species, are subterminally always rough-surfaced, and in some cases the roughness is seen to extend nearly all over the rays in that some obsolete microtubercles are found scattered even on the basal part. Such short rough hypogastralia appear to lead over gradationally into the gastralia which may exceptionally be diactinic. The fact here set forth indicates a close genetic relation between hexactinic gastralia and underlying diactinic megascleræ in general, and seems to be noteworthy in view of certain Hexactinellids, as e. g. *Staurocalyptus pleorhaphides*, in which the gastralia are represented, not by hexactins as in closely allied forms, but by diactins alone.

The *dermalia* (Pl. X., fig. 9, 12) are rather thick-rayed stauractins, the rays of which are in a plane slightly arched on the outside. Occasionally pentactins with the unpaired ray directed proximad and rarely tauactins are met with, but these are certainly exceptional. Length of ray as measured from the central point, 110–176  $\mu$ . Thickness at base, 13  $\mu$  on an average. The rays slightly narrow outwards; the tip is rounded or somewhat conically pointed. Their surface is thickly beset all over with unusually strongly developed, erect and conical prickles, which constitute one of the most striking characteristics of the species. The quadrate meshes formed by apposed rays of the dermalia measure generally 100–130  $\mu$  in length of sides.

The *gastralia* (Pl. X., figs. 10, 13) are strong and prickly hexactins, for the most part fully twice as large as the dermalia or

even much larger. The rays are somewhat more tapering towards their ends; the prickles on the surface are in like manner strongly developed. Length of ray, 250–400  $\mu$ . Thickness at base, 21  $\mu$  on an average. The quadrate meshes formed by the paratangentials of the gastralial measure generally 275–330  $\mu$  in length of sides.

Special mention should be made of the fact that in the Sci. Coll. specimen I have not infrequently met with paratangentially disposed, diactinic gastralial, in which the aborted rays are at most represented by vestigial bosses. The manner of their situation in company with the hexactinic form, together with the nature of the prickles on the surface, leaves no doubt as to the legitimacy of considering them to be gastralial. As already mentioned, they seem to be linked to the hypogastralial by means of intermediate forms. But their presence in the species seems to be inconstant, for in Mr. OWSTON'S specimen I have not succeeded in discovering a single diactinic gastralial.

In the specimen belonging to the Sci. Coll., a thin *basidictyonial plate* is found to cover the surface of that part of the coral on which it grows. The plate consists of amalgamated hexactins and pentactins, arranged for the most part in a single layer. The spicules have comparatively short rays which may be as thick as 23  $\mu$  and whose surface shows a sparse quantity of microtubercles. Several basidictyonalia were found still lying loose and separate in the proximity of those that had fused together to form the reticular plate.

The *oxyhexaster* (Pl. X., figs. 4–7) occurs very abundantly in all parts except the ectosome. Especially plentiful is it in and near the endosome. Diameter, 100–130  $\mu$ . There exists no

appreciable difference in appearance between those in the periphery and others situated more deeply in the wall. Forms like those depicted in Pl. X., figs. 4-6, predominate. From each exceedingly short principal there diverge 2 or 3, seldom 4, rather thin, obsoletely rough-surfaced and nearly straight terminals. The microtubercles on the basal parts of these frequently have the distinct appearance of being retroverted. Occasionally the oxyhexaster is hemihexactinose (fig. 7); i. e., while one or more of the six principals bear each two terminals, the rest are uni-terminal, in which latter case the entire ray is either straight or else is bent at the base. The quite hexactinose oxyhexaster occurs but very rarely; only one or two instances of it being all that I have encountered.

The *macrodiscohexaster* (Pl. X., figs. 2 & 3) is much smaller than that of either *A. schulzei* or *A. iijimai*, a fact which at first made me hesitate somewhat to refer the present species to the same genus; but on further consideration I can but think that its generic separation on account of that difference alone can scarcely be justified.

The *macrodiscohexaster* may be said to be spherical in shape. It measures 80-120  $\mu$  in diameter, being therefore of about the same size as average oxyhexasters of the species or somewhat smaller. It is tolerably rich in the number of terminals, which are not quite thin and are generally straight and nearly uniformly thick throughout their length. Not less than 5 terminals arise, not in a circle but promiscuously, from the swollen knob-like end of each very short principal. The terminal discs are small; they are furnished with minute marginal teeth, six or more to each.



The *microdiscohexas* (Pl. X., fig. 8) is relatively very small, measuring only 20–23  $\mu$  in diameter. It is an exceedingly delicate object and might easily escape attention. Spherical in shape, it is of the usual appearance and structure, so that a special description appears superfluous. I have found them on the whole sparsely distributed in the gastral membrane, though in some parts of it they are rather common. They occur also in the dermal membrane but exceedingly rarely.

### Soft Parts.

The collector of the Sci. Coll. specimen had put a small piece cut from it into alcohol at the spot of capture; so that, I was enabled to make some observation on the soft tissues stained and sectioned in the ordinary way.

The dermal membrane is film-like, perforated by large and mesh-like pores.

The trabeculae are thin, though in places membranously expanded. They form a dense cobweb at the pillars joining the ectosome to the choanosome (Pl. X., fig. 12) and also in the subgastral space. The cobweb is borne on the free proximal rays of the gastralia in a tent-like manner (Pl. X., fig. 13). The well-stained trabecular nuclei measure about  $2\frac{1}{2}$   $\mu$ .

Archæocytes are met with in small groups on the outside of flagellated chambers (Pl. X., fig. 15). Thesocytes with well-stained spherical contents, are present in some numbers.

The chambers show the usual shape and arrangement (Pl. X., fig. 12). They are cup-like or glove-finger-like with a diameter of about 140  $\mu$ . Their wall (Pl. X., fig. 15) is open-meshed, the beams being thin, finely granular and but little



stained. The choanocyte nuclei appear pale, being not more strongly stained than the reticulum-forming protoplasm. They contain one or more chromatic bodies resembling nucleoli. They can be observed with an unusual degree of distinctness (Pl. X., fig. 12); this may be due in a measure to their relatively large size, measuring  $3\frac{2}{3}$ — $4\frac{1}{3}$   $\mu$  in diameter (as against  $1\frac{1}{2}$ — $1\frac{7}{10}$   $\mu$  in *Euplectella marshalli*). They are thus much larger than either trabecular or archæocyte nuclei. In optic sections of the chamber-wall (Pl. X., fig. 14), the choanocyte nuclei appear oval in shape, as the result of their being flattened. I believe that I have seen the flagellum in some cases but the collar could never be brought into view with any degree of distinctness.

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### C. ACANTHASCINÆ.

Saccular, moderately thick-walled, often distinctly laterally compressed. Pentactinic hypodermalia generally present; exceptionally wanting. Gastralia, hexactins; sometimes pentactins, stauractins or diactins. Parenchymalia, exclusively diactins; never hexactinic. Hexasters consist of oxyhexasters and discohexasters; the latter being generally in two varieties, the discoctaster and the microdiscohexaster. The former is invariably present, but the latter may be wanting; no strobiloplumicome.



on this account deserving perhaps to be erected into a new and distinct genus. It frequently happens in firmly fixed forms that the basal region is bent to a greater or less degree; this probably results from the sponge growing on an inclined or vertical substratum while the main part of the body stands erect, directing the osculum upwards (Pl. XIV., fig. 14; Pl. XVII.; etc.).

The body is often laterally compressed, so that we may speak of the median sagittal plane that divides the body into symmetrical lateral halves. The bending of the sponge-base, whenever it occurs with a laterally compressed body, is invariably in this plane (see Pl. XVII.; etc.); so that the bent base is subjected to the same lateral compression as that of the main body,—a rule, the applicability of which is not restricted to the Acanthascinae alone but extends to the Rossellidæ in general.

Many species have the power of opening secondary oscula on the general body-wall or of budding out daughter persons, although neither of them are ever formed in any great number. Some species seem to be more prone to forming them than others. A daughter person first arises as a cœcum-like outbulging of the wall, eventually to open an osculum at the summit. In the case of the laterally compressed mother body, it may be given as the rule that the bud formation takes place on or along the median edge, generally in the lower part (Pl. XVII.; Pl. XX., fig. 2., etc.).

As to the spiculation, the *parenchymalia* are always and exclusively diactins. Hexactins never occur amongst them. When a number of the diactins are combined into bundles, some of them may be distinguished from the rest as the *pricipcialia* on account of their greater strength. The *principalia* are elongate

spindle-like, bow-like or boomerang-like; in the last case they have an elbow-like bend in the middle. They gradually taper towards both pointed ends; the surface is in most cases smooth throughout; the spicular center is never marked by a swelling in the external contour.

The *comitalia*, i.e., the finest parenchymal diactins directly surrounding the principalia, are filamentous spicules which are nearly uniformly thin throughout and are subterminally always rough-surfaced, ending with rounded or conically pointed tips. They may sometimes show either an annular swelling or four boss-like prominences around the spicular center. The principalia and the comitalia are in all cases intergradationally connected by such diactins as are intermediate in form and dimensions.

Certain parenchymalia under special circumstances seem to become protruded on the external side of the body-wall and thus form the diactinic needle-like *prostalia* found in a number of species. In certain *Staurocalyptus* and *Rhabdocalyptus* the prostalia of the kind in question are present on all parts of the body as long as the sponge is young and small (Pl. XV., fig. 3; Pl. XXII., figs. 3-5; etc.); but with growth of body, they are either lost or become restricted to the oscular margin where they may form an ill-defined palissade-like fringe (*marginalia*).

A hypodermal system of spicules is always differentiated. For *Acanthascus* it is characteristic that the hypodermalia consist exclusively of diactins. In both *Staurocalyptus* and *Rhabdocalyptus* they consist of moderately large pentactins, of which the cruciate paratangentials, representing two complete axes, support the dermal layer either alone by themselves or in union with a greater or less quantity of diactinic hypodermalia. The paratangential rays of individual pentactins, which are smooth or shagreened or else are

armed with prongs, are often, though not always, paratropal, *i.e.*, they are, as it were, pushed to one side in their plane so that they form with one another three acute angles and one obtuse angle greater than  $90^{\circ}$  or even  $180^{\circ}$ . Similar hypodermal pentactins have long been known in *Rossella antarctica*. As in this species they are generally found in groups of several together. In every such group, the proximally directed shafts, accompanied by comitalia, form a more or less compact column or tuft that dips deep into the choanosome, while the four-rayed heads produce on the sponge surface a star-like figure in which a number of streaks, *i.e.*, the paratangentials, radiate in all directions from a central space (Pl. XIII., fig. 12; Pl. XVIII., fig. 16; Pl. XIX., fig. 23; Pl. XXII., fig. 16; etc.). It is easy to discover that the separate pentactin-heads in a hypodermal group lie one above another in close order, the upper one of any two being older and more fully developed than that next below (see Pl. XVIII., fig. 16; etc.). The lowest is therefore the youngest, which develops while clasping in one of its angles the column of shafts belonging to older pentactins. It is this preëxisting shaft-column that disturbs the regularly cruciate development of the paratangentials, forcing these to deviate sideways from their normal directions; hence, their paratropal arrangement. In *Rhabdocalyptus* it is in the older pentactin-heads only that the rays are armed with prongs; in the younger and therefore the more deeply situated heads the rays are smooth.

The hypodermal pentactins remain in the *locus nascendi* only in certain species. More often they are destined to be protruded outwards through the dermal layer and thus to form a second kind of pleural prostalia, the other being the diactinic prostalia before mentioned. The *pentactinic prostalia* stand out isolated or

in tufts and the paratangential rays of their heads form a gossamer-like veil at a certain distance from the dermal surface, exactly as is known also in some Rossellids outside of the Acanthascinae. It is the oldest pentactinic hypodermalia that are thus shifted out; therefore, in *Rhabdocalyptus* the paratangentials of pentactinic prostalia are always found to be pronged.

It may here be remarked that the basal anchoring spicules of *R. plumodigitatus* KIRKP. ('OI) represent in all probability a special adaptation of the pentactinic prostalia of the species.

On the inside of the sponge-wall, *hypogastral* strands are usually more or less distinctly observable. They are to all appearance nothing else than certain parenchymal bundles that have dissociated themselves to a certain degree from the parenchymal mass and have entered into the support of the endosomal layer. They are seen to pursue a sinuous course and to intersect one another at irregular intervals.

Turning back to the external surface, the *dermalia* are small rough-surfaced spicules which may be pentactins, stauractins or straight diactins. All the three forms or any two of them, the number of whose rays are consecutive, may occur together in a species, but it is usual that one or the other of the said forms predominates to a greater or less degree. Hexactins, tauactins, orthodiactins and monactins are quite rare and exceptional, if any of them occur at all among the dermalia as they do in some species. Pentactinic dermalia have the unpaired ray always directed proximad. When stauractins or pentactins constitute the main elements of the dermal layer, their cruciate paratangentials are so arranged as to bring about a delicate latticework with more or less regularly quadrate meshes; whereas, in species with diactinic dermalia the meshes formed are triangular, trapezoidal



or irregular in shape, a fact which can easily be observed under the hand-lens and may be depended upon in concluding that the dermalia are diactins and not forms with cruciate paratangentials.

The *gastralia* are, with some exceptions, rough hexactins. In the exceptional cases, they are represented by pentactins intermixed with some stauractins (*A. cactus*), or by pentactins and stauractins with occasional tauactins and diactins (*S. heteractinus*), or by diactins alone (*S. pleorhaphides*, *R. plumodigitatus*). The diactinic gastralia may insensibly intergrade with hypogastral diactins. In the pentactinic forms the unpaired ray is always directed away from the gastral cavity. In the hexactinic forms the free proximal ray is often developed to a greater length than any of the other rays. The cruciate paratangentials may form, as they constantly do in several species, a continuous quadrate-meshed gastral layer covering the excurrent canalar apertures, but in several other species they are normally so sparsely present as to leave in the endosome gaps by which the excurrent water passes out freely into the gastral cavity (*A. cactus*, *S. dowlingi*, *S. solidus*, *S. tubulosus*, *S. japonicus*). Also in cases in which the gastralia are diactins (*S. pleorhaphides*, *R. plumodigitatus*), a continuous gastral layer is not developed, and hence the excurrent canalar apertures are left freely open.

A *basidictyonal plate* (Pl. XII., fig. 37; Pl. XV., fig. 12; Pl. XVIII., fig. 14; Pl. XXI., fig. 12; etc.) seems to be possessed by all the species that are firmly attached at base to the hard substratum. The dictyonal framework discovered by F. E. SCHULZE ('99) in the buds of *R. mirabilis*, the like of which will be described by me under *S. glaber*, I hold to be identical with the plate in question. For the significance I attach to the structure, the reader is referred to my Contrib. III., p. 24, foot-note.

In the Acanthascinae the basidictyonal plate is never of any considerable thickness, but always thin and insignificant. The elements (*basidictyonalia*) composing it are, as usual, small but comparatively thick-rayed hexactins—sometimes spicules with a less number of rays—in which the rays are roughened by the presence of microtubercles either all over the surface or near the ends only. The spicules are both directly and synaptically fused with one another, forming a rigid framework with irregular meshes, though there may occasionally occur such as are yet unfused or are in the process of fusing together. The uneven limiting surface presented by the plate against the substratum is covered by a special, thin and sieve-like siliceous layer perforated by very small meshes (*vide* especially Pl. XXI., fig. 12). This limiting reticular layer, which may be regarded as a part of the basidictyonal plate or mass, was long ago noticed and figured by F. E. SCHULZE (Chall. Rep., Pl. LXIV., fig. 3). It is a structure that reminds one of the "Deckschicht" that is known to cover the exterior of many fossil Dictyonina. Occasionally fine axial canals in the form of a plane cross are found inclosed in its beams (Pl. XXII., fig. 17), indicating that a stauractin, which may be classed under the *basidictyonalia*, is structurally involved in it; but by far the greater part of the layer consists of synaptical-like deposits formed in connection with the *basidictyonalia* present and invariably in direct relation with the foreign body with which the sponge-base is in contact. It sometimes happens on fragments of the limiting layer taken from certain species or individuals, that no basidictyonal spicules in union with the beams can be seen. This may be due to their being somehow concealed from view, perhaps in that they are too sparse and widely scattered to be easily discovered. At the same time I

hold it not impossible that their development may under circumstances be quite suppressed, in which case the limiting layer alone would stand for the basidietyonal plate.

Finally with respect to the *hexasters*, it may be said that there are three forms occurring together in a species; *viz.* oxyhexasters, discoctasters and microdiscohexasters.

The *oxyhexasters* are the most abundant of all. Strong and wide-spread is the tendency shown by them to assume hemihexactinose and quite hexactinose forms. In some species the hemihexactinose form predominates; in some others, the hexactinose. In *R. tenuis* (F. E. SCH.), as before alluded to, all the oxyhexasters present appear to be hexactinose. Basing our description on normally developed oxyhexasters, the principals are always very short,—often so exceedingly short as to be called vestigial. The number of terminals most frequently borne by a principal is two;\* but it may sometimes be three and rarely four. The terminals are nearly smooth or more frequently rough. The roughness may be developed on their basal parts into retroverted prickles or barbs. In several species the oxyhexasters situated in the periphery of the sponge-wall, but particularly in the subdermal

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\* For those oxyhexasters generally in which the principals appear bifurcated in that they are provided each with two terminals, it has been given by F. E. SCHULZE ('97 a) as an approximate rule that the plane of bifurcation of a principal stands at right angles with that of another belonging to the same axis, and that the six separate bifurcation planes in one oxyhexaster of the kind correspond to the so-called secondary planes of symmetry in the isometric crystal system, the primary or principal planes of symmetry being given by the principals forming the three axes. So that the principals and the terminal forks should represent all the nine possible planes of symmetry distinguishable in a regular crystal (three principal planes determined by the axes and six secondary planes determined by diagonally opposite edges of a cube). I have not specially gone into the testing of the truth of the above statement; but so far as concerns the two bifurcation planes at the ends of any one axis, my experience makes me hesitate to lay it down as a general rule that they are relatively vertically oriented to each other, for the angle referred to seemed to me to be much too variable and indefinite, as observed in a large number of cases in various Hexactinellid species.

region, differ from those more deeply situated in having somewhat longer principals and slightly more slender terminals. Moreover, the former generally show a greater total number of terminals, being usually normally developed, although hemihexactinose and hexactinose forms may be common among the latter. (Compare in Pl. XXI., figs. 4 and 5 with figs. 6-8; in Pl. XXII., figs. 7 and 8 with figs. 14 and 15). It must however be borne in mind that between the peripheral and the more deeply located oxyhexasters there is always a gradual transition within one and the same sponge.

Of the three oxyhexaster-forms occurring together in a species, it is usually the hexactinose amongst which are found individual oxyhexasters with greatest diameter or axial length,—a fact which I have noticed also in some Rossellinæ. It appears as if the reduction in the number of terminals to the minimum, *i.e.*, to one to each principal, in a measure favors the growth of the spicule in general size.

In a number of the species I have specially gone into the observation of the axial cross in hexactinose oxyhexasters. With a little trouble I have found it in all cases an easy matter to demonstrate what I have repeatedly emphasized as to the extent of the axial filaments in the central parts of that oxyhexaster variety. For the rest I may let fig. 25, Pl. XIV., speak for itself. By the side of that figure is another (fig. 24) showing, for the sake of comparison, the extent of the axial cross in the central part of a normal oxyhexaster in which each principal is supplied with two terminals.

It scarcely needs to be reiterated that uniterminal principals, irrespective of their occurrence in a hemihexactinose or in a hexactinose oxyhexaster, are joined to their single terminal mostly

in a straight line in such a manner that the point of junction of the two parts is externally not in the least indicated; but the terminal may sometimes be bent at base exactly as in a hexaster ray with two divergent terminals, save that one of these terminals is entirely wanting, in which case it may be said to be well marked off from the principal bearing it.

The *discoctasters* are spicules peculiar to the Acanthascinæ; in fact their presence constitutes the only reliable criterion by which a Rossellid can be determined as a member of that subfamily. Hence a misgiving might be entertained that should they chance to be simply overlooked or not properly identified, or if there existed a species which had lost them only secondarily, the sponge in question would likely be taken up under the Rossellinæ, which are apparently *ab origine* without these characteristic spicules.

The *discoctasters* were first recognized by F. E. SCHULZE ('93) to be strongly modified discohexasters in which the six principals have entirely or almost entirely atrophied while the terminals have undergone a new arrangement into eight secondary principals and terminal tufts at points of the central node corresponding to the eight corners of a cube. It was pointed out by the above-mentioned writer that there may exist on the central node and in the center of the space surrounded by every four secondary principals a hump-like prominence representing the outer end of a primary principal, and further that this protuberance may run out at base into four radial ridges (see Pl. XI., fig. 20), marking the course along which the original terminals were laid down in order to combine into the eight secondary principals. These are frequently not quite cylindrical being longitudinally ribbed or at any rate somewhat angulate in cross-section, indicating



their formation by a coalescence of parts running lengthwise. If more support is needed to establish the correctness of F. E. SCHULZE's enunciation as to the nature of the discocaster, a noteworthy fact may be adduced with respect to the typical triaxial cross of filaments inclosed in the central node, which I believe I was the first to demonstrate in the spicule under consideration ('97). As I have repeatedly had occasion to remark, the cross becomes plainly visible if the spicule be examined in glycerine or in any other medium of a refractive power similar to that of the siliceous substance, and its six points are seen to be always directed towards the middle of the space surrounded by every set of four secondary principals. That space is either simple-surfaced and somewhat concave or shows in the middle the hump-like protuberance before alluded to. In the latter case, each arm of the axial cross extends directly into the protuberance towards which it is directed (see Pl. XI., fig. 20). Of some interest is the not infrequent occurrence of malformed discocasters in which there exist such a primary terminal or terminals as stand out from the central node, having apparently been left free without fusing with any of the secondary principals (Pl. XIII., fig. 5; Pl. XVI., fig. 10; Pl. XVIII., fig. 6; etc.). The cases may be said to be in a measure suggestive of the condition of the spicule before the primary terminals were brought together and joined into the eight secondary tufts. Noteworthy also seems the presence of minute vacuole-like spaces in the secondary principals and sometimes also in the central node (Pl. XII., figs. 25, 27; Pl. XV., fig. 9; etc.). In the former as well as in the ridges running out from the six protuberances on the central node, the little spaces are usually found arranged in a row or rows that run longitudinally. There can scarcely be a doubt as to their being vacancies between the



primary terminals, left unfilled by the siliceous deposit which solders these together (*cfr.* p. 116).

The free terminals at the end of secondary principals are always rough, though often obsoletely so. The minute terminal discs are either simple like pinheads or else toothed at the margin. The general size of discoctasters and the proportion and shape of their parts are of great systematic value and may be utilized in distinguishing the different species. It frequently happens that in one and the same species the deeply situated discoctasters are considerably larger than those in the periphery of the wall.

The *microdiscohexasters* are minute and extremely delicate rosettes of the usual structure. In general shape they seem to be uniformly spherical, measuring under  $40\mu$  in diameter. In some species the diameter is only about  $15\mu$ . Not that they have been observed in all Acanthascine species, for several species have been found to be without them, though it is difficult to decide in all cases if that negative result was not due simply to oversight or to the individuality of the sponge.

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#### ACANTHASCUS F. E. SCH.

Hypodermalia, diactins only; at any rate, no pentactins amongst them; hence, never veiled.

This genus, as originally established by F. E. SCHULZE in the Challenger Report, included, besides *A. cactus*, two other species that were called *A. grossularia* and *A. dubius*; neither of these however possesses discoctasters, and hence can not be placed under the Acanthascinae. The former has since been declared by the same writer ('97, p. 537) to represent merely a young specimen of *Rossella antarctica* CARTER, while the latter was recognized to be a species which should properly be called *Rossella dubia* (F. E. SCH.). Subsequently in '98 (p. 55) I described *A. alani* from the Sagami Sea and in '99 (p. 45) F. E. SCHULZE put forth his *A. platei* from the Californian coast (E. of St. Diego, 572 m.). Accordingly, the genus as it now stands, comprises three species, the differential characters of which may be gleaned from the following key:

- a.*—Dermalia, predominantly stauractins, occasionally pentactins; gastralia, mostly pentactins, sometimes stauractins. Oxyhexaster, 90–152  $\mu$  dia. Discoctaster, 106–300  $\mu$  dia. Microdiscohexaster, 15–23  $\mu$  dia. .... *A. cactus* F. E. SCH.
- b.*—Dermalia, predominantly pentactins, usually with a knob-like rudiment of the distal sixth ray; gastralia, hexactins.
- a*<sup>1</sup>.—Oxyhexaster, 100–130  $\mu$  dia. Discoctaster, 120–250  $\mu$  dia. Microdiscohexaster, at most 20  $\mu$  dia. .... *A. platei* F. E. SCH.
- b*<sup>1</sup>.—Oxyhexaster, 144–190  $\mu$  dia. Discoctaster, 136–220  $\mu$  dia. Microdiscohexaster, 30–35  $\mu$  dia. .... *A. alani* IJ.

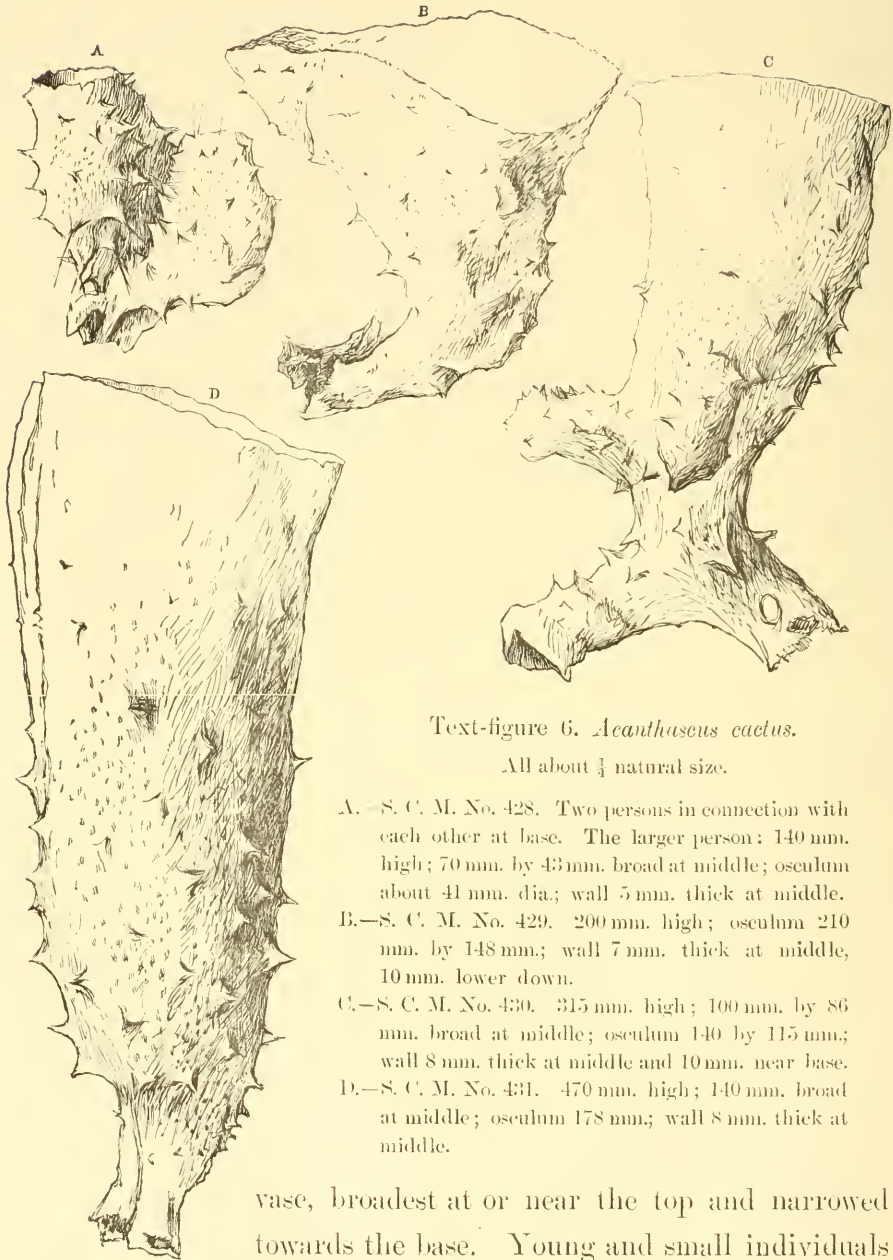
### ACANTHASCUS CACTUS F. E. SCH.

Pl. XI., figs. 16–22 and Pl. XII.

*Acanthascus cactus*. F. E. SCHULZE, '86, p. 49. '87 (!), p. 148; Pl. LVII., figs. 1–7. '97, p. 551.—IJIMA, '97, p. 48.

The species was first described by F. E. SCHULZE from a single small specimen which was obtained by DÖDERLEIN probably from a shop in Enoshima. Some years later, as the fishermen became aware of the demand by naturalists, specimens began to be brought to us in such numbers that soon we had to decline to purchase them unless unusually large in size or beautiful in appearance. Evidently the species is one of the most abundant and most widely distributed Hexactinellids of the Sagami Sea. It is known to the fishermen along the coast under the name of "Wata" (cotton) or "Wataboshi" (cotton-hood). Nearly half a hundred specimens now lie before me, all obtained from depths between 220 and 572 m. and from a bottom of volcanic origin in the Sagami Sea. The more exact localities known to me are: Yodomi, Mochiyama, Inside Okinosé, Outside Okinosé and Homba. I myself have collected several fragments at a spot about 2 kilometers off the village of Senzu on the northern coast of Vries Island, from a depth of 220 fathoms and a bottom of a black basalt-like rock. Mr. T. TSUCHIDA, Assistant in the Misaki Marine Laboratory, obtained some fragments on the north of Okinosé from a depth of 235 fathoms. In 1900, the U. S. Fish Commission S. S. "Albatross" trawled up several fragments, together with *Rhabdocalyptus mollis*, at her Station 3697 (about 4 kilometers off the mouth of the Sakawa river in Sagami Province; 265-120 faths.; black volcanic mud). While most specimens grow on a tufaceous substratum, I have seen some attached to the dead skeletons of other Hexactinellids (*Hexactinella ventilabrum*, *Farrea occa*).

On the following page are given sketches of a few selected specimens in order to give an idea of the general appearance of the sponge. The shape is in general like that of a wide-mouthed

Text-figure 6. *Acanthascus cactus*.All about  $\frac{1}{3}$  natural size.

- A.—S. C. M. No. 428. Two persons in connection with each other at base. The larger person: 140 mm. high; 70 mm. by 43 mm. broad at middle; osculum about 41 mm. dia.; wall 5 mm. thick at middle.
- B.—S. C. M. No. 429. 200 mm. high; osculum 210 mm. by 148 mm.; wall 7 mm. thick at middle, 10 mm. lower down.
- C.—S. C. M. No. 430. 315 mm. high; 100 mm. by 86 mm. broad at middle; osculum 140 by 115 mm.; wall 8 mm. thick at middle and 10 mm. near base.
- D.—S. C. M. No. 431. 470 mm. high; 140 mm. broad at middle; osculum 178 mm.; wall 8 mm. thick at middle.

vase, broadest at or near the top and narrowed towards the base. Young and small individuals generally show the wall somewhat closed in at the oscular margin. This, in the larger specimens, is usually directed straight upwards

or otherwise somewhat outwards. Sometimes the body expands superiorly in such a manner that it presents a funnel-like shape. The sponge stands either erect from the basal attachment or is bent more or less in the basal part. Laterally it is frequently more or less distinctly compressed, especially in the basal region; but the upper part is about as often simply roundish or irregularly roundish in cross-section.

The wide and deep gastral cavity extends close to the inferior end, so that the blind wall presenting the irregularly shaped surface of basal attachment is not thicker than the adjoining part of the lateral wall. This is on the whole only moderately thick, gradually thinning above towards the thin and simple-edged oscular margin.

While many specimens represent pure and simple individuals, each being in possession of a single large osculum at the superior end, others show complication in that they consist of a main person bearing one, two or sometimes more, generally much smaller daughter persons secondarily produced by budding. The bud is at first a blind-sac-like outbulging of the wall, which eventually opens an osculum at the top. The oscular rim is for some time closed inwards but may flare out later. The bud-formation seems to be confined to the basal region, or at any rate to the lower half of the mother body. Text-figure 6, *A*, represents a case in which two persons, one somewhat smaller than the other, arise side by side from a common basal part. The specimen shown in *C*, same figure, bears three buds: two on the convex sagittal edge of the bent basal region, and one on the lateral side. Several cases have been encountered of specimens similarly bent at base and bearing on the convex side a single bud directed in the opposite direction from the main part of the mother sponge, the

general shape being then not unlike that of the *Rhabdocalyptus* shown in Pl. XVII. The buds are sometimes represented merely by secondary oscula which are unaccompanied by any outbulging of the surrounding parts and thus appear like simple gaps in the wall. Thus, the specimen marked *B* in text-figure 6 is in possession of more than one small such osculum in addition to the large primary one at the superior end.

The species grows to very considerable dimensions. The largest complete specimen before me (S. C. M. No. 432) is 432 mm. high, and consists of two large persons and of a boss-like cœcum of the size of one's fist, all these parts arising from a common basal portion. There is also in the Science College a larger fragment with an osculum measuring 240 mm. in diameter. On the other hand, the smallest individual I have seen was only about the size of a walnut.

A striking feature of the sponge consists in the sharply apexed conical elevations of the external surface. These occur at various but rather wide intervals. They are usually most numerous, largest and tallest near the middle or in the lower half of the body. In large specimens they may be as high as 25 mm., but are much shorter in the smaller specimens. They grow more and more sparse superiorly towards the osculum, becoming at the same time smaller and more inconspicuous, until they no longer exist close to the oscular margin.

The cones bear on the apex moderately strong, needle-like prostalia lateralia, which project either singly or in tufts of a few together to various lengths, up to about 20 mm. They are directed on the whole radially, though frequently inclined obliquely one way or the other. When the prostalia are well preserved, as is especially the case in the smaller specimens, the resemblance



of the sponge to a cactus is so remarkable that one is at once impressed with the appropriateness of F. E. SCHULZE's selection of the specific name. No doubt all the cones arise in connection with the prostalia, but it is by no means uncommon that we meet with such as show no trace of the latter, which evidently have been lost. Cones without prostalia are especially frequent in the larger and therefore older individuals; in fact in these it is rare that we find any of the prostal needles at all. The loss is undoubtedly partly due to a mechanical breaking off at the apex of the cones due to some external cause, as is proven by the proximal part of the needles still remaining in the cones, the outer end being broken off. At the same time I am inclined to assume that a large part of the loss is to be accounted for by the fact that the spicules in their entirety are cast off by some natural physiological process of the sponge. Only in this way can be explained the entire absence of even the proximal remnant within the cones in so many cases. Probably the longer and therefore older prostals are the first to be thrown out, and in support of this theory stands the fact that those still remaining on the larger specimens are not so long nor so strong as some to be seen on the smaller individuals. If I am right in the above assumptions, it follows that the period of the greatest development of the prostalia is when the sponge is comparatively small and young, or at any rate before its full size is attained—a fact which is not without parallel in other Acanthascinae (*S. glaber*, *R. victor*, *R. capillatus*).

Near the oscular margin there may occur some fine prostalia which project either singly or in small tufts without having cones at bases. They are however never so numerous as to form anything like a fringe to the osculum.

Figs. 16 and 17, Pl. XI., show in natural size the appearance of the endosomal and the ectosomal layer respectively. A close familiarity with the characters of either will be sufficient to enable one to recognize the species even if the specimen to be determined be a small fragment, provided of course one or the other of the layers is well preserved.

In the ectosome (Pl. XII., fig. 34) the extremely delicate dermal layer exhibits minute quadrate meshes, just discernible as such with the naked eye. Much more distinct is the hypodermal latticework (see Pl. XI., fig. 17), the meshes of which are triangular, trapezoidal or polygonal in shape and measure rarely over 2 mm., but far more frequently less than 1 mm., in the length of their sides. Towards the apex of the cones the hypodermal beams converge more or less from all sides, making the meshes between them narrower but more elongate than in other parts. The beams may measure up to  $130\mu$  in breadth. They are therefore not very thick, but still are thick enough to be distinctly perceived with the unaided eye. The points of intersection often appear somewhat thickened in a node-like manner, owing to dense concentration there of the soft parts. The subdermal space in the intervals between the incurrent canalar apertures may be as wide as 1 mm. It is traversed by numerous strands, the pillars, connecting the ectosome to the choanosome. The apertures of the incurrent canals are of various sizes. In the larger specimens, the largest canals may reach 4 mm. in diameter but are in general much smaller.

The gastral surface is on the whole tolerably smooth, though it may sometimes exhibit a wrinkled appearance. The canalar apertures on this side of the wall are on the whole larger, but necessarily less in number, than those on the external side of the

same specimen (*cf.* Pl. XI., figs. 16 and 17), as is the rule with all Hexactinellids of similar shape and structure. All the ex-current canalar apertures, in fact the entire gastral surface, is covered over by a well differentiated endosome (Pl. XI., fig. 16; Pl. XII., fig. 35). In this the gastralia are however never so abundantly present as to form a continuous layer of latticework by themselves; so that, the endosomal meshes, which present themselves as such to the naked eye, may be said to be freely open, except for some fine and insignificant trabeculae of the gastral membrane that may occasionally extend across them. The said meshes are of about the same size and shape as those of the hypodermal framework; only they are generally more rounded at the corners, while the beams inclosing them are perceptibly thicker. These beams, so far as the skeletal parts are concerned, consist in the main of the strands of hypogastralia, along which there occur the gastralia proper in scattered distribution together with numerous hexasters. Certain hypogastral strands are somewhat conspicuously thicker than the rest and can be traced continuously for a considerable distance, pursuing an irregular course and frequently intersecting others of similar strength.

The sponge in the living state is colorless or whitish. The texture may be said to be rather firm.

### Spiculation.

As to the spiculation I have but little of importance to add to what is already known through the investigations of F. E. SCHULZE. To that gentleman I am indebted for the gift of a slide-preparation made from the type-specimen described in the

Challenger Report, which preparation was of great service to me in insuring a correct identification of specimens in the early stage of my studies.

Principal *parenchymalia*, elongate spindle-like, sometimes bow-like. Length, up to 15 mm.; thickness at middle, up to 300  $\mu$ . Thier pointed ends smooth, but sometimes rough as in all the smaller *parenchymalia*. There exists a gradational series of variously sized *parenchymalia*, from the principalia down to comitalia of only 6  $\mu$  thickness. (Fig. 36, Pl. XII., is intended to illustrate the different modes of termination of the parenchymal diactins. Unfortunately the representation of the subterminal roughness in the thinner spicules has turned out to be a failure).

The *prostalia* are diactins of great length, which may measure up to 25 mm. or more. They are probably to be looked at simply in the light of excessively elongated parenchymal principalia. Like these, the part imbedded within the sponge-wall is accompanied by filamentous comitalia as well as by other loosely and radially arranged *parenchymalia* whose outer ends are directed towards the apex of the cones.

The *hypodermal* and *hypogastral* strands consist of diactins, and of diactins only, which are arranged in loose or compact bundles of variable strength (Pl. XII., figs. 34 and 35). The elements look much like *parenchymalia* of similar dimensions. They are generally not longer than 3 mm. nor broader than 38  $\mu$  in the middle. Towards both ends they gradually taper, the very tip being either simply acuminate or conically pointed. Subterminally, the surface is roughened by microtubercles which

are however never numerous present. Usually the spicular center is externally provided with a gentle annular swelling; more rarely, with two opposite protuberances.

When the sponge is torn from the rock to which it was attached, the basidictyonal plate is left adhering to the latter. The plate can easily be separated out by boiling in acid. It is found to be in places quite thin, being represented by an uneven and small-meshed siliceous reticulum (the limiting layer of the basidictyonal plate, see p. 134), the beams of which may at intervals show spicular axial filaments in the form of a plane cross (as in Pl. XXII., fig. 17). At other places there exists, besides the same limiting or attachment layer and in direct union with it, a somewhat wider-meshed sponge-work (Pl. XII., fig. 37) which increases the thickness of the basidictyonal plate to half a millimeter or more. The relatively thick beams of the sponge-work are rough-surfaced all over on account of the presence of numerous conical microtubercles. The manner of their arrangement is apparently irregular, but by exact observations it is not difficult to make out that the foundation to the structure is given by certain hexactins, the basidictyonalia, which are directly as well as synaptically fused together. Isolated instances also occur of diactins or of parts of diactins—apparently belonging to the parenchymalia—being incorporated in the beams. Observed in glycerine, such a diactin is seen to be of smooth-contour and distinctly traversed by the axial canal but entirely enveloped by an irregular and synaptica-forming secondary deposit of siliceous matter. But by far the greater part of the parenchymalia in the region have their lower end simply loosely inserted into the interspaces of the basidictyonal framework.

*Dermalia* predominantly stauractins, rough all over, nearly plane or slightly arched so as to be convex on the outer side (Pl. XII., fig. 23). Axial length, 200–350  $\mu$ . Rays perceptibly tapering towards the rounded tip or nearly uniformly thick; sometimes slightly swollen at the ends. Thickness at their middle,  $8\frac{1}{2}$   $\mu$  on an average. The quadrate meshes formed by mutual apposition of the rays of separate dermalia measure on an average 165  $\mu$  in length of sides.

Occasionally among the dermalia there occur pentactinic forms in which the proximally directed, unpaired ray is somewhat shorter than, or nearly equally as long as, the paratangentials. They scarcely ever occur on the cones. Under exceptional circumstances a stauractin may have one of the rays so shortened that it approaches a tauactin in shape. A few cases of unusually small, smooth and slender-rayed oxystauractins and oxypentactins that I have seen I hold to be dermalia in an incomplete state of development.

*Gastralia* rough pentactins, in which the unpaired ray is directed distad (Pl. XII., fig. 24); occasionally stauractins. They are quite like the dermalia, though perhaps on the whole slightly smaller. As before mentioned they are never so numerous as to form a continuous gastral lacework, occurring, as they do, in widely scattered distribution on the hypogastral strands (see Pl. XII., fig. 35).

*Oxyhexasters*, 90–152  $\mu$  in diameter (120  $\mu$  on an average). Those occurring in abundance in the choanosome as well as in the endosome (Pl. XII., figs. 29–32) have mostly exceedingly short principals which in many cases may be said to be almost



reduced to nothing. In them the terminals are comparatively strong, reaching up to nearly  $5\mu$  in thickness at base; they are absoletely rough all over. The roughness is especially pronounced at their base and here it may often be distinctly observed, under a very high power of the microscope, that it is caused by reverted microtubercles or minute barbs. Each principal may bear two, seldom three or four, divergent terminals, thus giving in all 12 or more than 12 terminal points to the entire oxyhexaster. More usually the oxyhexasters seem to be hemihexactinose and not seldom quite hexactinose (figs. 30 and 31). In the former case, the principals are biterminal if not uniterminal. Thus, forms with 11, 10, 9, 8, 7, or only 6 terminal points are not uncommon.

Of the oxyhexasters situated in the subdermal space, many (not all) are considerably different in appearance from those described above and which are more deeply situated in the wall. In them the principals are appreciably longer and more slender, while the terminals are simply more slender; moreover, there occur as a rule two or three terminals to each of the six principals. One specimen of such peripheral oxyhexasters is to be seen in Pl. XI., fig. 18, on the right hand side. A comparison of that oxyhexaster with the others shown in Pl. XII. will at once make apparent the differences above indicated.

In all the oxyhexaster varieties the central cross can easily be brought into view and the extent of its arms exactly determined, if proper steps be taken in preparing.

Pl. XII., fig. 33 represents a case of what seems to be an abnormally developed oxyhexaster. It was met with but once in the dermal membrane of a certain specimen and may possibly have been only an extrinsic object. Central node irregularly

shaped, but still with indications of the six principals. Total number of terminals, 20 at least; some of them bifurcated at the end as shown in the figure.

*Discoctasters* (Pl. XII., figs. 25 and 27) various in size, measuring  $106\text{--}260\ \mu$  in diameter. Secondary principals  $\frac{1}{3}\text{--}\frac{1}{2}$  as long as the free part of the terminals. Number of terminals in a tuft, 3-7; most usually 4 or 5. The discoctasters in the periphery of the wall are the smallest ( $106\text{--}137\ \mu$  dia.), while those in the deepest parts may be twice as large (generally  $200\text{--}260\ \mu$  in diameter). In other respects than in size there also exist some noteworthy differences between the two.

The smaller peripheral discoctasters (fig. 25) usually show distinct hump-like prominences on the central node, in the middle of the spaces surrounded by every set of four secondary principals. The four ridges radiating from the prominence towards and into each principal are also generally but not always distinct. The principals as seen in a lateral view are frequently uneven in contour; a more exact observation may show that they are longitudinally ribbed throughout the length, indicating their formation by a coalescence of parts running lengthwise. Pl. XI., fig. 20, representing the central part of a discoctaster taken from the subdermal region, demonstrates the points mentioned above, besides showing the disposition of the axial cross in the central node and the series of small vacuole-like spaces contained in the ridges that go to form the secondary principals. The terminals are obsoletely rough-surfaced; their disc at the end is minute, appearing simply like a pinhead.

In the larger, deeply situated discoctasters (fig. 27), the central node may be so large as to measure  $20\ \mu$  across. On it

the hump-like prominences are seldom seen, these being usually either merely indicated or not at all present. The space where they should occur may even be concave. It seems that the prominences, as also the ridges arising from them, disappear as the central node becomes larger with the growth of the entire spicule; possibly they become, so to say, covered up by the siliceous deposit added to the node. The secondary principals, which may measure  $7\frac{1}{2}\mu$  across in the middle, are obsoletely rough-surfaced. The terminals are similarly rough. Near their outer end the roughness grows somewhat coarser and is here seen to be caused by retroverted microtubercles (Pl. XII., fig. 28). In direct proximity to the terminal disc, which marginally runs out into 7 or 8 small teeth, there exists a very short tract devoid of the microtubercles.

Not rarely malformed discoctasters are met with, in which some primary terminals have apparently failed to unite in the proper way with any of the secondary principals but remain more or less free, appearing like supernumerary appendages to an ordinary discoctaster. As a case of such malformation is to be considered the spicule figured by F. E. SCHULZE in the Challenger Report, Pl. LVII., fig. 4.

Of special interest are the isolated cases of true discohexasters I have come across in certain specimens and which I consider to represent the primitive form whence the discoctaster was derived. In general size and in the appearance of the terminals they are exactly comparable to the smaller discoctaster of the periphery, but the essential difference consists in the fact that the principals are six in number, these being short, thick and knob-like and arranged in the usual disposition. Four or five terminals arise divergently from each principal. The discohexaster,

which is much too rare and inconstant to be counted among the regular hexasters of the species, may be said to be in appearance not unlike the macrodiscohexaster of *Aulosaccus ijimai* F. E. SCH.; it is apparently in the state of nearest approach to the discoctaster, into which it may become converted by comparatively short steps of change.

*Microdiscohexasters* (Pl. XII., fig. 26) of only 15–25 $\mu$  diameter and of the usual appearance are common in both the dermal and gastral membranes as well as in the subdermal and subgastral trabeculae. In some individuals they are much more abundant than in others. In the choanosome they do not seem to occur. In stained preparations a nucleus—in all probability representing a silicoblast—is almost always seen in each of the angles formed by the principals, as shown in Pl. XI., fig. 18. The interspaces between the exceedingly delicate terminals are filled up by a protoplasmic matrix, so that the entire rosette first attracts one's attention as a small, faintly colored mass of spherical shape.

### Soft Parts.

Some fragments fixed and preserved by myself at different times at the place of capture have been utilized for making the following observations on the soft parts.

The *chambers* are so numerous and densely crowded together that it is difficult to exactly determine the shape and extent of each (see Pl. XI., fig. 22). However there can be no doubt of their being as usual cup-like or thimble-like in shape. The

diameter varies from  $90\mu$  to  $190\mu$ . The chamber wall I have seen as a reticular membrane with *open* meshes (Pl. XI., fig. 19). The choanocyte nuclei, though scarcely differentially stained as they lie in the nodes of the reticulum-forming granular protoplasm, can at places be distinctly recognized as such. They are of about the same size as the trabecular nuclei. None of the preparations are such as to allow anything to be said about the flagellum or the collar.

On the outside of, and in close apposition to, the chamber wall are variously sized groups of well-stained *archæocytes* reaching up to  $3\frac{1}{2}\mu$  in diameter. A small group of the same is seen in Pl. XI., fig. 19, on the left. The *archæocytes* lie close together, generally arranged in a single layer flat upon the chamber wall or between the walls of directly adjacent chambers.

The *trabeculae*, both external and internal, are as usual cobweb-like. Their nuclei, measuring about  $2\mu$  in diameter, are well-stained and contain generally more than one chromatic granule.

Along the lumen of the larger canals, both incurrent and excurrent, the trabeculae are at places extensively expanded into a thin lining film, so that they might be spoken of as constituting here a canalar membrane.

The dermal membrane (see Pl. XI., fig. 18, left) is film-like perforated by large and small "pores" of roundish or oval shape. The parts between closely adjoining "pores" may be reduced to mere threads indistinguishable from the trabeculae. Not only does the essential agreement in histological nature but also the fact that the same thesocytes and microdiscohexasters occur in both

the dermal membrane and the trabeculæ, strengthen me in the belief that the two parts just mentioned are genetically and fundamentally one and the same structure, whatever differences apparently exist between them being due to the circumstances of their respective situations (see Contrib. I., pp. 122, 147).

The gastral membrane is of much the same appearance as the dermal.

The *thesocytes* of the species are of a characteristic appearance. They may occur in the dermal and gastral membranes as well as on trabeculæ in all parts of the sponge-wall, but seem to be most abundant in the subdermal region. They are shown in numbers in Pl. XI., fig. 18, in which they appear as morula-like masses consisting of numerous small spherules. The quantities in which they occur are subject to variation according to individuals; but they seem to be present all the year round, since I have observed them in specimens preserved in the months of April, July, August and December.

The thesocytes are spherical, ovoid or somewhat irregular in shape and may be more or less flattened when situated on or against a membranously expanded trabecula. They measure 8–20  $\mu$  across. A fine cell-limit and the nucleus are only exceptionally distinguishable; the former can be perceived only when the spherules contained in it are not developed in too excessive numbers, while the latter is generally concealed among the spherules.

The spherules, which measure 1.7–2.5  $\mu$  are refractive and homogeneous, appearing yellowish in the unstained state. Their reactions towards different stains have already been noticed on p. 178 (foot-note) of my Contribution I. and therefore need not be



mentioned here. They are generally tolerably uniform in size within a thesocyte. In certain cases, however, I have found them quite unequal in size, the larger ones appearing to have arisen from the combination of several smaller ones. Further in certain individuals I have not infrequently met with thesocytes in which the spherules were apparently in the process of disintegrating into irregular granules; or in other cases, of dissolving into a diffuse state. The differences in appearance may be partially due to the drastic influence of the preserving reagents; nevertheless I believe that they may in general be taken as representing the changes which the spherules, as a nutritive substance held in reserve, undergo by a natural physiological process before they are consumed. And it would be but natural if we should find that some thesocytes are quite or nearly quite devoid of the fat-like contents as the result of consumption. As such thesocyte relics I consider certain pale-looking cells which are now and then found wherever thesocytes might be expected to occur. A few cells of the kind in question are to be seen in the left upper part of fig. 18, Pl. XI. They are of about the size of ordinary thesocytes filled up with spherules. Probably they are of a more or less collapsed shape. The faintly colored and finely granular cytoplasm incloses a distinct nucleus, while its external limit is well-defined and is sometimes distinctly provided with an enveloping membrane. The cells can scarcely be viewed in the light of early thesocyte stages *before* the formation of the spherules; for, there exist other cells which alone can be viewed as inceptual thesocytes, *viz.*, those very much smaller than full-sized thesocytes and which already contain the spherules though yet in quite a limited number.

I may here add that in some instances the fat-like spherules

presented the appearance of dispersing after having been set free from the thesocyte which originally contained them all. Quite isolated spherules, evidently the same as those of thesocytes, are occasionally found sticking to the trabeculae.

The peculiar rosette-like bodies depicted in Pl. XI., fig. 21, were met with in profusion in a preparation of a specimen taken in April. Reference to them has already been made on p. 31 of this Contribution, under *Scyphidium longispina*. The body consists of a varying number of well-stained spindle-like or rod-like pieces in radial arrangement. These measure up to  $4\mu$  in length. The figure was included in the plate under a suspicion that the bodies might represent stages in the spermatogenesis, but now I think they are something, extrinsic or otherwise, at any rate quite foreign to the sponge.

### ACANTHASCUS ALANI IJ.

Pl. X., figs. 16-23.

*Acanthascus alani*. IJIMA, '98, p. 55.

The species is based on a single specimen (Pl. X., fig. 16) which originally belonged to Mr. ALAN OWSTON (O. C. 4097) but is now in the collection of the British Museum.

It is a dried specimen greatly macerated on the exterior. In shape it is ovoid, goblet-like and slightly laterally compressed. The lower end contracts into a short, stalk-like and irregular

base. Total height, 190 mm. Greatest breadth of body, 133 mm.; lesser breadth in the same region, 104 mm. Stalk-like base, about 60 mm. in greatest breadth. Superiorly the body-wall closes in towards the thin oscular margin which is apparently simple-edged. The irregularly roundish osculum is about 60 mm. in diameter. The deep gastral cavity extends into the stalk-like base. The body-wall in the lower part is as thick as 35 mm.

Notwithstanding the lacerated condition of the external surface, it can be ascertained that this was by no means smooth but must have shown a number of irregular hillock-like or ridge-like elevations, judging from what appear to be their rests. The more prominent of the elevations may have been 10 mm. high, as measured from the bottoms of adjacent depressions. Possibly their summits were originally provided with diactinic prostalia as in other species of the genus, but no such spicules have been found preserved in the specimen.

Fortunately there has remained the ectosome in some places, though in small patches (Pl. X., fig. 23). It is uneven, being much creased. The minutely and more or less regularly quadrate meshed dermal lacework is exceedingly delicate; it is supported below by fine intersecting hypodermal strands, mostly under 0.1 mm. in thickness, which pursue a sinuous course. Over the interapertural spaces, as also over the external prominence, the ectosome is generally in close contact with the choanosome, so that it can not be very clearly distinguished. Where it has fallen off, the sponge-surface appears somewhat crisp-hairy on account of the dishevelled fibers of the parenchymal strands. The stalk-like base presents the usual fibrous texture.

The incurrent canalar apertures measure mostly under 5 mm.

in diameter, though a few may be as large as 9 mm. Those of an approximately similar size lie separated from one another by a space nearly equally as wide as, or sometimes much wider than, their diameter.

On the gastral side, the endosome is not developed in a continuous layer, so that the excurrent canalar apertures all open freely into the gastral cavity. The apertures are of various sizes, some being as wide as 15 mm.; their edge is either sharp and distinct or but slightly indicated. The interapertural space shows an irregular interlacing of fine fibers.

All the principal spicules are very fine, which fact accounts for the soft and delicate texture of the sponge. The septa between the two systems of canals are thin; consequently, the sponge is light, and cavernous in appearance. Its general aspect is not unlike *Chaunoplectella cavernosa* or *Aulosaccus schulzei*.

The species is apparently more closely allied to *A. platei* than to *A. cactus*. From the former it is distinguishable by a number of points, of which I may mention the relatively wider canals, the freely open excurrent apertures, the smaller discoctaster and the larger oxyhexaster and microdiscohexaster.

### Spiculation.

*Parenchymal diactins* small, slender; generally less than 1 mm. in length and at most 12  $\mu$  thick. In the stalk-like base, they may be over 1 mm. long and 30  $\mu$  thick but can scarcely be said to be coarse. Center, usually without external swelling or bosses. Nearly uniformly thick throughout except at the ends which are more or less swollen and rough; extreme tip rounded. Oxyhex-

actins met with here and there in preparations of the septa are either canalaria or gastralía.

Hypodermalia quite like the above.

*Dermalia* (Pl. X., fig. 16), almost always pentactins; usually with a gentle prominence representing the distal sixth ray. Rays, slightly attenuated outwards but with rounded tip; microtubercles, not numerous, nor strongly developed, so that the roughness of surface is not pronounced. Axial length, generally 250–350  $\mu$ . Breadth of rays at base, 9–11  $\mu$ .

*Gastralia* (Pl. X., fig. 18), hexactins; irregularly scattered. Rays, like those of dermalia but with less roughness of surface. Axial length, 280–460  $\mu$ . Hexactins similar to the gastralía occur along the excurrent canals as *canalaria*. In the incurrent canals pentactins resembling dermalia were occasionally found; they are probably to be considered likewise as canalaria.

*Oxyhexaster*, present in abundance. Diameter, 144–190  $\mu$ ; on an average 160  $\mu$ . From the characters of its rays, two varieties can be distinguished; both seem to occur together promiscuously.

In the one variety (Pl. X., fig. 20) the center is swollen to a globular node, while the short principals are rounded in a knob-like manner. Slender rough terminals, generally 3 or 4, arise from each principal. They seem to be very liable to be broken off near the base, the fragments being found in abundance in the soft parts. It seems that this is the more abundant of the two oxyhexaster varieties.

In the other variety (Pl. X., fig. 21) the terminals are considerably stronger while the principals are much less distinctly

indicated, being in fact quite abortive. Number of terminals to each principal, generally 2; seldom 3 and sometimes only 1 to some of the principals. Insignificant microtubercles are sometimes seen on the surface of terminals, at the base of which they are reverted barb-like.

*Discoctaster* (Pl. X., fig. 19), common in all parts; varying in size. Diameter, 136–220  $\mu$ . Central node, always with the six boss-like prominences. Secondary principal, about as long as, or longer than, the terminal tuft. The latter consists of 6–8, fine terminals (drawn too thick in the figure); narrow at base and expanding more or less distally. Terminal disc, small and pinhead-like.

*Microdiscohexaster* (Pl. X., fig. 22), very sparsely present, having been found in canalar septa only in a few instances after a careful search; spherical, with 30–35  $\mu$  diameter. Central node, swollen to spherical shape. Principals moderately long, with numerous fine terminals.

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### STAUROCALYPTUS IJ.

IJIMA, '97, p. 53.

Hypodermalia include pentaactins in which the paratangentials are smooth or rough, but never armed with spines. Generally veiled, sometimes not.



The genus, as I consider it at present constituted, comprises the eleven species embodied in the following

### Differential Key to Species.

*a.*—Dermalia nearly exclusively, or at any rate predominantly, pentactins.

*a*<sup>1</sup>.—Discoctasters (both subdermal and subgastral) of less than 200  $\mu$  dia.; rarely up to 213  $\mu$  dia.

*a*<sup>2</sup>.—Thin-walled. Gastral surface with a continuous endosomal layer covering over the excurrent canalar apertures. (Without prosthelia. Discoctasters 80–100  $\mu$  dia.; with characteristically short and cylindrical tufts of terminals).....  
.....*S. fasciculatus* F. E. SCH. (Coast of California, 690 mm.).

*b*<sup>2</sup>.—Tolerably thick-walled. Gastral surface without a continuous endosomal layer, the excurrent canalar apertures opening freely.

*a*<sup>3</sup>.—Without prosthelia (?). With peculiar pit-like subdermal cavities whence arise narrow incurrent canals. Excurrent canalar apertures wide (up to 8 mm. dia.). (Discoctasters 128–180  $\mu$  dia.).....  
.....*S. roperi* (F. E. SCH.) (Coast of Patagonia, 731 m.).

*b*<sup>3</sup>.—With both pentactinic and diactinic prosthelia. Subdermal cavity inconspicuous. All canals narrow, even extremely narrow; not more than 2 mm. wide.

*a*<sup>4</sup>.—Gastral surface smooth. Among the gastral pentactins more numerous than hexactins. Rays of dermalia and gastralia smooth basally. (Discoctasters 150–200  $\mu$  dia.).....  
.....*S. solidus* F. E. SCH. (Coast of California, 486–1254 m.).

*b*<sup>4</sup>.—Gastral surface hairy on account of short projecting ends of fine diactins. Gastralia hexactins. Rays of dermalia and gastralia entirely rough. A considerable number of stauractins among the dermalia. (Discoctasters 130–213  $\mu$  dia.).....*S. tubulosus* n. sp. (Sagami Sea).

*b*<sup>1</sup>.—Subgastral discoctasters larger than 220  $\mu$ , reaching up to nearly 300  $\mu$  or over in diameter; subdermal discoctasters considerably smaller. (Tolerably thick-walled; with pentactinic and generally also diactinic prosthelia; canals comparatively narrow).

*c*<sup>2</sup>.—Smallest discohexasters not smaller than 200  $\mu$  dia. (in fact 228–320  $\mu$  dia.). Gastral surface smooth. Prosthelial pentactins small; their paratangentials up to 2.2 mm. in length. Principal parenchymal oxydiactins under 8 mm. in length and 41  $\mu$  in thickness. Gastral hexactins 80–100  $\mu$  in length of rays.....  
.....*S. doulingi* (LAMBE). (Pacific coast of N. America, 63–512 m.).

*d*<sup>2</sup>.—Smallest discohexasters (subdermally situated) much smaller than 200  $\mu$  dia. Gastral surface with numerous projecting diactins. Prosthelial pentactins moderately large; their paratangentials reaching up to 4 mm. or considerably more in length. Principal parenchymal oxydiactins much coarser than in *c*<sup>2</sup> (may be 80–600  $\mu$  thick). Gastral hexactins on the whole as large or decidedly larger than in *c*<sup>2</sup>.

- c*<sup>3</sup>.—Gastral surface hairy on account of short projecting ends of fine diactins. Excurrent canalar apertures mostly freely open; in some places covered over by an irregularly coarse-meshed endosomal layer. Oxyhexasters largely hexactinose.....*S. affinis* n. sp. (Sagami Sea).
- d*<sup>3</sup>.—Gastral surface conspicuously hispid on account of projecting and rather coarse diactins. All excurrent canalar apertures covered over by an irregularly coarse-meshed endosomal layer. Oxyhexasters, rarely hexactinose. ....*S. entacanthus* n. sp. (Sagami Sea)
- b*.—Dermalia nearly exclusively, or at any rate predominantly, stauractins.
- e*<sup>1</sup>.—With small and inconspicuous proctal pentactins. (Dermalia uniformly microtubercled on all sides). Gastralia hexactins, forming a continuous lacework in the endosome. Discotasters 114–128  $\mu$  dia.....*S. microchetus* IJ. (Sagami Sea).
- d*<sup>1</sup>.—Without proctal pentactins, the dermal surface being smooth, (though in *c*<sup>2</sup> isolated and slender proctal diactins may sometimes occur).
- c*<sup>2</sup>.—Dermalia decidedly spiny on the external side but obsoletely microtubercled on the inside of rays. Gastralia hexactins in which the free proximal rays are over 450  $\mu$  in length; forming a continuous gastral lacework over excurrent canalar apertures. Discotasters very large, 500–660  $\mu$  in diameter.....*S. glaber* IJ. (Sagami Sea).
- f*<sup>2</sup>.—Dermalia slightly rough. Gastralia pentactins and stauractins, with rays up to 100  $\mu$  length; not forming a continuous layer over excurrent canalar apertures. Discotasters 110–210  $\mu$  diameter.....*S. heteractinus* IJ. (Sagami Sea).
- c*.—Dermalia straight diactins. (Gastralia represented likewise by diactins. Discotasters 140–200  $\mu$  dia. Sponge veiled and with long diactinic proctalia.....*S. pleorhaphides* IJ. (Sagami Sea).

In the present Contribution I propose to treat in full nine species which I have studied.

*S. fasciculatus* and *S. solidus* are two American species of which my knowledge has been solely derived from the describer's work (F. E. SCH., '99). I beg here to offer a few remarks with regard to both.

*S. fasciculatus* is undoubtedly a well differentiated species. Its peculiarly characterized discotaster (only 80–100  $\mu$  large and with 4–6 terminals, about 12  $\mu$  long, forming a cylindrical tuft not broader than the principal of over 20  $\mu$  length) should alone be sufficient to distinguish the species from all the rest in the genus.

With respect to *S. solidus* it seems that F. E. SCHULZE (*l. c.*, p. 52) regards it to be distinct from the closely similar *S. dowlingi* mainly on the strength of two peculiarities, *viz.*, that the general shape is invariably barrel-like, straight and broad-based instead of being cup-like, outbulged on one side and narrowed towards the base; and that the discoctasters are much smaller and more slender-rayed. It occurs to me that perhaps some other points might well be added to the specific difference, to which view I am led from certain facts contained in F. E. SCHULZE's own description and figures. On p. 105 (*l. c.*), in a short diagnosis of *S. solidus*, is a statement to the effect that as gastralialia there occur a greater number of pentaactins than hexaactins; whereas, in *S. dowlingi* the same spicules are known to be hexaactins and only occasionally pentaactins. Again, on his Plate X. (*l. c.*), F. E. SCHULZE gives figures of the dermalialia and gastralialia from *S. solidus*; both the spicules mentioned are shown to have rays which are basally quite smooth, instead of being rough all over as in *S. dowlingi*. The differential characters above indicated, if shown to be constant, would certainly be of no small importance in distinguishing the two species.

Concerning the three new species described for the first time in this Contribution (*viz.*, *S. tubulosus*, *S. affinis* and *S. entacanthus*), it may here be mentioned that they are all very nearly related to *S. dowlingi* and that some of the specimens on which they are based were at first referred by me to that species, though with some hesitation. The characters of the specimens referred to were therefore taken into account in drawing up the diagnosis of *S. dowlingi* in my "Revision of Hexactinellids with discoctasters" (IJIMA, '97, p. 53). However, a renewed examina-

tion of the Japanese materials and a comparison with typical *S. dowlingi*, the characters of which have since become more precisely known to me, have led me to think that I was mistaken in the identification. *S. dowlingi* is, for the present at least, to be eliminated from the list of Japanese Rossellids; on the other hand, I think it fairly justifiable, under the circumstances, to add to the list the three new species mentioned above. But I can not

\* Table showing some points in the characters of those *Staurocalyptus* species (or speci-

Name of species.	Size of specimens described.	Dermal side.			Gastral side.	
		Diactinic prostalia.	Pentactinic prostalia.	Incurrent canalar apertures.	Projecting needles.	Excurrent canalar apertures.
<i>S. fasciculatus</i> F. E. S.	"Albatross" specimen, 150 mm. high.	Not found.	Not found.	Small.	Not found.	Entirely covered by "gastral membrane."
<i>S. raperi</i> (F. E. S.)	"Challenger" specimen, 160 mm. high.	Not found (abraded?).	Not found (abraded?).	Small.	Not found.	Large; up to 8 mm. dia.; freely open.
<i>S. solidus</i> F. E. S.	"Albatross" specimens. Up to 290 mm. high.	Numerous; strong.	Numerous; strong.	Moderately large.	(Gastral surface smooth).	1-2 mm. dia. All freely open.
<i>S. dowlingi</i> (L. M. J.)	Canadian and Californian specimens, 100-120 mm. high.	Numerous; strong.	Numerous; small.	Small; up to 1½ mm. dia.	Occasionally present.	All freely open.
<i>S. tubulosus</i> IJ.	S. C. M. No. 241. 50 mm. high.	Present in some numbers; strong.	Present; on the whole small.	Very small; up to ¼ mm. dia.	Numerous; fine and short; hairy.	Very small; all freely open.
<i>S. affinis</i> IJ.	S. C. M. No. 194. Moderately large	Not found; probably owing to abrasion.	Not found; probably owing to abrasion.	Up to ¾ mm. dia.	A few present.	Partly open and partly covered by an open-meshed endosomal lattice.
" " "	S. C. M. No. 400. 103 mm. high.	Present in some numbers; strong.	Present; large.	Small; up to 1½ mm. dia.	Present; fine and short; hairy.	ditto.
<i>S. entacanthus</i> IJ.	S. C. M. No. 242. Very large.	Not present.	Present in some places; small to moderately large.	Up to 3 mm. dia.	Numerous; strong; spinose.	Entirely covered by an open-meshed endosomal lattice.
" " "	S. C. M. No. 403. Much smaller.	A few present; weak.	Not found; evidently on account of abrasion.	Up to 2 mm. dia.	Numerous; strong; spinose.	ditto.

altogether suppress the apprehension that further studies on more material than is at present available may necessitate changes of greater or less importance in the systematic arrangement of the specimens now referred to those species.

(For use in comparing the characters of closely similar *Staurocalyptus* species, in which the dermalia are nearly exclusively or at any rate predominantly pentactins, I append, as a foot-note,\*

mens), in which the dermalia are predominantly or nearly exclusively pentactins.

Spicules.											
Parenchymal principalia.		Proctal diactin.		Proctal or hypodermal pentactin.	Pentactinic dermalia.	Hexactinic gas-tralia.	Oxyhexaster.		Discotaster.		Micro-discotaster.
Maximum		Maximum		Length of paratan-gentials.	Length of rays.	Length of rays.	Diameter of normal and hemi-hexactinose forms.	Hemi-hexactinose forms.	Diameter.		Diameter.
Length.	Breadth.	Length.	Breadth.						Peri- spherical discot.	Subgas- tral discot.	
					80- 150 $\mu$ .	100- 150 $\mu$ .	80- 100 $\mu$ .	Appa- rently nume- rous.	80-100 $\mu$ .		
Long.	35 $\mu$ .			Under 2 mm.	100- 165 $\mu$ .	100- 220 $\mu$ .	88- 130 $\mu$ .	Appa- rently rare.	128-180 $\mu$ .		22-24 $\mu$ or more.
						(Pentact- ins more nume- rous than hexact- ins).			150-200 $\mu$ . (160 $\mu$ in average).		
8 mm.	41 $\mu$ .	60 mm.	300 $\mu$ .	About 2.2 mm.	160- 180 $\mu$ .	80- 100 $\mu$ .	100- 120 $\mu$ .	Many.	228-320 $\mu$ .		20 $\mu$ .
12 mm.	130 $\mu$ .	20 mm. +	95 $\mu$ .	General- ly under 2 mm.; rarely 4 mm.	84- 190 $\mu$ .	130- 200 $\mu$ .	75- 115 $\mu$ .	Rare.	130- 170 $\mu$ .	175- 213 $\mu$ .	19 $\mu$ .
35 mm. +	600 $\mu$ .			7-12 mm.	130- 200 $\mu$ .	140- 240 $\mu$ .	130- 152 $\mu$ .	Very nu- merous.	120- 200 $\mu$ .	280- 400 $\mu$ .	20 $\mu$ .
25 mm.	520 $\mu$ .	40 mm.	180 $\mu$ .	5-6 mm.	100- 170 $\mu$ .	140- 175 $\mu$ .	115- 160 $\mu$ .	Very nu- merous.	160- 183 $\mu$ .	350- 380 $\mu$ .	19 $\mu$ .
9 mm.	250 $\mu$ .			2-4 mm.	130- 200 $\mu$ .	95- 130 $\mu$ .	100- 132 $\mu$ .	Not pre- sent.	155- 220 $\mu$ .	220- 286 $\mu$ .	Not found.
15 mm.	80 $\mu$ .			4-6 mm.	130- 200 $\mu$ .	140- 250 $\mu$ .	120- 186 $\mu$ .	Nume- rous.	143- 176 $\mu$ .	262-352, rarely 428 $\mu$ .	19 $\mu$ .

a table showing for each species or specimen certain noteworthy points from its characters).

**STAUROCALYPTUS RÆPERI (F. E. SCH.).**

Pl. XIV., figs. 26-32.

*Rhabdocalyptus Ræperi*. F. E. SCHULZE, '86, p. 51. '87 (!), p. 158; Pl. LXV. '97, p. 553.

*Staurocalyptus ræperi*. I. IJIMA, '97, p. 55. '98, p. 53,

The following account of this species is here introduced mainly to record certain points which go in a measure to supplement the excellent description we have already received from F. E. SCHULZE, the original describer, and which seem to be of importance for a sharp distinction between this and certain other species closely resembling it.

To the liberality of the investigator just mentioned I am indebted for a gift of two slide-preparations made from the type-specimen, and on which my own observations have been solely made.

The species was obtained by the "Challenger" to the south of Puerta Buono in Patagonia (depth, 731 m.). It should exhibit a medium-sized and moderately thick-walled, vase-like or cup-like body, firmly attached to the substratum by a short stalk-like base. No prostalia of any kind were found, possibly as the result of abrasion. Through the even ectosome were seen elongated, angular or spindle-shaped and pit-like subdermal spaces, whence arose rather narrow incurrent canals. On the gastral side the



large (up to 8 mm. dia.), sharply contoured, excurrent apertures were freely open, *i.e.*, not covered by endosome. The above seem to constitute the more important macroscopic features of the species.

As to the *spiculation*, all the skeletal elements are remarkable for their slenderness.

The strongest *parenchymal* diactins seem not to exceed  $35\ \mu$  in breadth. The parenchymalia in general have sparsely microtuberculated ends, the very tips being pointed. The smaller or the more slender of them show knobs cruciately disposed around the spicular center.

The oxypentactinic *hypodermalia* have slender paratangentials under 2 mm. in length and  $13\ \mu$  in thickness at base; these are smooth except at the rough outer ends and are not quite straight, but rather wavy.—Besides the oxypentactins, strands of diactins also serve to support the ectosome. These hypodermal diactins are of various lengths; they are all cruciately tubercled in the middle. While those of greater length are indistinguishable in appearance from a parenchymal diactin, the shorter ones may equal the dermalia in axial length and may have rays exactly similarly characterized as in the latter; so that, such short diactins, especially when in isolated positions, might as well be classed under the dermalia as under the hypodermalia. The statement therefore seems justifiable that the dermalia pass over by gradation to the parenchymalia through the intermediation of hypodermal diactins.

The *dermalia* (Pl. XIV., figs. 30 and 31) are predominantly pentaactins, not infrequently stauractins and rarely monaactins, not

to mention the occasional diactins above referred to. In all the different forms it is quite usual that the suppressed ray or rays are indicated by vestigial knobs. Such rays as are well developed are  $100\text{--}165\ \mu$  long and  $6\ \mu$  or less broad at base; the microtubercles on their surface are sparse and weakly developed; their tips are conically pointed. Not only are the rays considerably more slender than in the corresponding spicules of all other closely related species of the genus, but also the roughness of surface is far less pronounced, as has already been pointed out by F. E. SCHULZE.

The *gastralia* (Pl. XIV., fig. 32) are oxyhexactins with similarly characterized rays, which measure  $100\text{--}220\ \mu$  in length and not over  $5\ \mu$  in breadth at base. Over the interspace between the freely open excurrent canalar apertures, the gastralia are present in abundance, forming a nearly regularly quadrate-meshed latticework. In this, the laths are formed frequently by two or more gastral paratangentials combined in a loose strand.

The *oxyhexasters* (Pl. XIV., figs. 27, 28) are small and very slender-rayed. Diameter,  $88\text{--}130\ \mu$ . Those situated in the periphery of the wall are on the whole somewhat smaller than others in deeper situations. The short, often exceedingly short, principals bear each 2–3, nearly straight or slightly wavy and obsoletely rough terminals. Less frequently there is only a single terminal to one or more principals in an otherwise normal oxyhexaster (hemihexactinose). In the preparations at my disposal I have not discovered any regularly hexactinose oxyhexasters, but I presume that the spicules spoken of by F. E. SCHULZE as “small, weakly developed oxyhexacts” (Call. Rep., Pl. LXV.,

fig. 6) and which should occur isolated are nothing else than such. Their rays are said to be wavy and to have a rough surface (F. E. SCH., '97).

It frequently happens that in biterminal rays of the oxyhexasters a third terminal is represented by a minute spine which seems not to have attracted F. E. SCHULZE's attention. In Pl. XIV., fig. 28, I have figured a case in which every principal bears a spurious terminal besides two well developed ones. Special examinations were made to convince myself of the fact that the minute spine was not an axial elongation of the principal to which it belonged. In one instance I observed a principal bearing two terminals which were quite normally disposed except that one of them was very much shorter and more rudimentary-looking than the other. There can be no doubt whatever that the cases in question represent stages preliminary to the reduction of the number of the terminals.

The *discoasters* (Pl. XIV., fig. 26) measure 128–180  $\mu$  in diameter. Those situated subdermally seem to show no appreciable difference in any respect from others lying near the gastral surface. The slender secondary principal, not over 4  $\mu$  broad, is nearly as long, in some cases only about  $\frac{1}{2}$  as long, as the free terminals belonging to it. The terminals number 2–5, usually 3 or 4, in a tuft which broadens but slightly in the distal direction. They are nearly straight; the surface is obsoletely rough when seen under a very high power of the microscope. The minute terminal disc is always shaped like a pinhead, and not marginally toothed.

The delicate *microdiscohexasters* (Pl. XIV., fig. 29) are found in tolerable abundance in the gastral region. Diameter, 22–24  $\mu$

(32  $\mu$ , according to F. E. SCH.). In shape they are spherical, the six tufts of terminals in the same spicule being not widely separated from one another. The terminals are not very numerous; they are exceedingly fine and about twice as long as the principal.

The slimness of the rays in all the spicules, the sparsely microtuberculate character of the dermalia and gastralia as well as the small size of the discoctaster seem to make up the more conspicuously distinctive features in the spiculation of this species.

### STAUROCALYPTUS DOWLINGI (L. M. LAMBE).

*Rhabdocalypthus dowlingi*. LAMBE, '93 (!), p. 37; Pl. III., figs. 2, 2a-2h.—F. E. SCHULZE, '97, p. 554.

*Staurocalypthus dowlingi*. F. E. SCHULZE, '99 (!), p. 47; Pl. IX., figs. 1-6.—(Not IJIMA '97, p. 53; nor IJIMA '98, p. 53).

The following account of this species is given more for the purpose of furnishing basis with which to compare certain Japanese forms, than to give the results of my own observations on the sample taken from the Canadian type-specimen and which was kindly sent to me at my request by Mr. L. M. LAMBE of Ottawa.

As mentioned before (pp. 165-167) I now consider, contrary to my earlier assumption (Ij. '97), that this species is not represented in the Japanese waters so far as is known at present. The localities then to be assigned to the species are: Strait of Georgia (Canada; about 63 m.), near St. Rosa Island (California; 221 m.), and near Lenard Rock (Aleutian Islands; 512 m.).

According to the descriptions of L. M. LAMBE and F. E. SCHULZE, the species should show a tolerably thick-walled broadly sacciform body, somewhat outbulged on one side and narrowed at base. It may attain a large size, as attested by a fragment of the wall 300 mm. long and 15 mm. thick, obtained by the "Albatross" on the Californian coast. From all over the dermal surface there stand out both diactinic and pentactinic prostalia. The gastral surface is smooth but may show in places the ends of some parenchymal oxydiactins projecting beyond it. The subdermal space is evidently of a quite insignificant width. The apertures of both the incurrent and excurrent canals seem to be small as a rule. LAMBE gives  $1\frac{1}{2}$  mm. as an average diameter of the larger and  $\frac{3}{4}$  mm. as that of the smaller incurrent apertures of a specimen 100 mm. high. The same specimen showed on the internal surface evenly distributed excurrent apertures of about  $\frac{3}{4}$  mm. diameter. A continuous endosomal layer is apparently not present over the excurrent apertures, which thus seem to open free into the gastral cavity.

The single imperfect specimen,—220 mm. high and 120 mm. broad,—obtained by the "Albatross" near the Aleutian Islands and referred to the present species by F. E. SCHULZE, requires special mention in so far as it has, in contrast to the specimens from Canada and California, very wide canals and subdermal spaces, on which account the upper part of the wall is said to have presented an appearance almost of a lamellar structure. It seems to me that this structural deviation apparently extends somewhat beyond the ordinary range of variability to be expected in different individuals of a Rossellid species.

With respect to *spiculation* the more important points, known

to me from the descriptions of LAMBE and SCHULZE as well as from my own observations, may be summed up as follows:

*Parenchymalia*, oxydiactins under 8 mm. length and  $41\ \mu$  breadth.

The small diactins with 2 or 4 knobs at the middle and of 0.28–1.37 mm. length, mentioned by LAMBE as occurring in the dermal and gastral layers and seen also by SCHULZE, are apparently either those that enter into the composition of hypodermal beams together with the paratangentials of oxypentactinic hypodermalia or what might be called the hypogastralia.

*Prostal oxydiactins*, as long as 60 mm. with a thickness of  $300\ \mu$ .

*Hypodermal oxypentactins*, mostly with orthotropical (*i.e.*, regularly cruciate) paratangentials, which are smooth and measure about 2.2 mm. in length. In those oxypentactins which stand out as prostalia, the paratangentials and the base of the shaft-ray have a densely granular surface.

*Dermalia*, rough pentactins; with rays rounded at end, 160–180  $\mu$  long and 10–13  $\mu$  thick. Exceptionally the dermalia are diactinic.

*Gastralia*, similar but somewhat smaller hexactins, with rays of 80–100  $\mu$  in length.

*Oxyhexasters*, numerous; each very short principal with two, straight, moderately strong and slightly rough terminals; 100–120  $\mu$  in diameter. Many are hexactinose (then up to 138  $\mu$  dia. or axial length); some others are hemihexactinose.

*Discoasters*, abundant especially in the deeper parts, 228–320  $\mu$  (as a rule 260  $\mu$ ) in diameter. Principals, short being  $\frac{1}{3}$ – $\frac{2}{3}$  of the entire arm-length. Terminals, nearly straight, slightly rough, 3–10 (most usually 4) in number to each slightly expanding



tuft. Terminal disc, pinhead-like or marginally toothed. Central node, generally without hillock-like prominences on its six sides.

*Microdiscohexasters*, common especially in or near the dermal and gastral layers; spherical; about  $20\ \mu$  in diameter.

The points to be especially noted in the spiculation of this species, in relation to that of others that very closely resemble it, seem to be the slenderness of principal parenchymal diactins, the small-size of proctal pentactins and the fact that the discoctasters do not fall below  $200\ \mu$  in diameter.

### STAUROCALYPTUS TUBULOSUS NOV. SP.

Contrib. III (IJIMA, '03), Pl. VI., figs. 11-17.

This is a species which, like certain others of the genus, is but little differentiated from *S. dowlingi* of the N. American Pacific coast and yet seems to deserve being erected into a distinct species. The only type-specimen of the species is shown in my Contrib. III., Pl. VI., fig. 11. The original (S. C. M. No. 241) was obtained in Homba from a depth of 572 m.

The specimen is a nearly complete individual of a slightly bent, tubular and spindle-like shape, 50 mm. long and 12-14 mm. broad at the middle, where the wall is about  $2\frac{1}{2}$  mm. thick. The body is somewhat laterally compressed. The oval osculum at the superior truncated end measures 4 mm. by 8 mm. in diameter. The inferior portion of the sponge gradually narrows towards the pointed torn-off base. The texture of the wall-tissue is rather firm.

A number of thin and isolated diactinic prostalia project at low angles from the lateral surface, and are directed obliquely upwards. They are generally 16 mm. or more in length. Close to the thin oscular edge they are more numerous than elsewhere but shorter, projecting straight upwards to a length generally under 3 mm. Here and there, especially near the oscular margin, some pentactinic prostalia are also found. These are not large nor numerous; they project to the extent of at most 1 mm. beyond the dermal surface. The latter is rather uneven, though no conical or papilla-like elevations exist.

The endosomal layer appears closely adherent to the choanosomal mass, which fact is undoubtedly greatly due to the smallness of the incurrent canals. The dermal lacework is but indistinctly visible even when observed under the lens. Beneath it are seen thin hypodermal fibers,—mostly the paratangentials of hypodermal pentactins,—intersecting one another in an indefinite way, while in places they converge towards several central points.

The incurrent canalar apertures are not larger than about 1 mm. across. On the gastral surface, the very small apertures of excurrent canals are of a roundish or irregular shape, measuring about  $\frac{1}{2}$  mm. in average diameter. They open close together, without being covered over by a special endosomal latticework. The entire gastral surface, when looked at horizontally, presents a finely and somewhat uniformly hairy appearance. This is caused by the trichodal ends of numerous parenchymal diactins freely protruding beyond the surface to the length of about half a millimeter or more.

Macroscopically the sponge may be said to be but slightly different in appearance from *S. dowlingi*, except perhaps in its

generally tubular shape and the peculiarly hairy character of the gastral surface. Certainly these features have yet to be shown to be constant before they can be finally accepted as specific differential characters. However they seem to me to be not unimportant when taken into consideration conjointly with certain points in the spiculation in which the present species stands in disagreement with *S. dowlingi*.

### Spiculation.

The *principal parenchymalia* are oxydiactins which not infrequently attain a length of 12 mm. and a breadth of 130  $\mu$  in the middle. Generally, however, they are much smaller, being under 10 mm. in length. The ends are finely attenuated and smooth-surfaced. Compared with *S. dowlingi*, the parenchymalia of the present species are on the whole considerably coarser. (In *S. dowlingi* the maximum dimensions of parenchymalia, in specimens very much larger than the type of *S. tubulosus*, are known to be length 8 mm. and breadth 41  $\mu$ ).

The *oxydiactinic prostalia* may attain 20 mm. or more in total length and 95  $\mu$  in greatest breadth. (In *S. dowlingi* 60 mm. by 300  $\mu$ ).

The *oxypentactinic prostalia* are generally small, inconspicuous and usually isolated, but sometimes stand out in small loose groups. The paratangentials are either paratropal or nearly regularly cruciate. Their length rarely reaches 4 mm.; more generally they are much shorter (under 2 mm.). In the prostalia situated close

to the oscular margin, they measure scarcely 1 mm. in length. The proximal ray (shaft) may be twice as long as the paratangentials in one and the same spicule. In size and shape the spicules in question seem to agree approximately with those of *S. dowlingi*, but the paratangentials in the present species show a noteworthy feature, perhaps peculiar to the species, in the close-set microtubercles that give roughness to their surface. The microtubercles are not rounded as usual but take the form of fine, short and sharply pointed microspines (Contrib., III., Pl. VI., fig. 13), somewhat as in *Lanuginella pupa* and *Scyphidium longispina* (this Contrib., Pl. I., fig. 7 and Pl. II., fig. 3). They stand nearly vertically or slightly inclined outwards, giving a fine and densely hirsute, rather than "granular," appearance to the surface beset by them. This appearance is acquired by the paratangentials before the pentactins are protruded as prostalia, apparently as the last step in the development of hypodermal (*i. e.*, prospectively prostal) pentactins. This is clearly indicated by those groups of hypodermal pentactins (Contrib. III., Pl. VI., fig. 12) in which the most superficially situated pentactin-head consists of rough paratangentials while another or others following in deeper levels are smooth and successively more slender rayed.

A small number of diactins associate with the paratangentials of hypodermal pentactins in forming the support to the dermal lacework.

The *dermalia* (Contrib. III., Pl. VI., figs. 14 and 15) are predominantly rough pentactins but intermixed with a goodly number of stauractins. The former frequently, but not always, show a knob-like relic of the atrophied sixth and distal ray. Rarely and exceptionally I have encountered hexactins among

the dermalia. In all these the rays taper slightly towards the rounded or obtusely pointed ends. Their length as measured from the spicular center, 84–190  $\mu$ ; on the average about 140  $\mu$ . Breadth of rays near base, 7–12  $\mu$ . I have noticed that the stauractins attain on the average a considerably larger size than the pentactins (see Contrib. III., Pl. VI., fig. 12). (For the sake of comparison I may mention that in *S. dowlingi* the dermalia are known to be generally pentactins and occasionally diactins. Length of rays, 160–180  $\mu$ ; according to LAMBE, 160  $\mu$  on the average).

The *gastralía* are all hexactins with rays similar in appearance to those of the dermalia. Length of rays, 130–200  $\mu$  (in *S. dowlingi*, 80–100  $\mu$ ).

*Oxyhexasters* (Contrib. III., Pl. VI., fig. 17) occur in abundance. They are mostly normally developed; less frequently are they hemihexactinose. Quite hexactinose forms are very rare. The central node is often swollen to a spherical shape. The principals are as usual short—often exceedingly short. The diameter is in general 75–115  $\mu$  (in *S. dowlingi* 100–120  $\mu$ ).

The oxyhexasters in the subdermal region mostly measure less than 100  $\mu$  in diameter. In them the terminals are slender, slightly rough and 2 or 3 in number to each principal.

Those situated more deeply in the wall are on the whole somewhat larger, many also having perceptibly stronger terminals, which are then nearly smooth-surfaced.

From this species again I am in a position to record a case of an oxyhexaster in which five of the principals bore each a set of two, nearly equally developed terminals, but the sixth principal

ran out into a single normal terminal besides showing near its base the short and spurious rudiment of a second terminal. By one short step of reduction, the oxyhexaster might change itself into a hemihexastinose form with one uniterminal principal.

The *discoctasters* may in general be said to have a diameter of 130–213  $\mu$ ; the principal takes up nearly one half or somewhat less of the entire ray-length. Terminals straight, nearly smooth, 2–5 in a tuft which broadens gradually and slightly outwards. The smaller discoctasters show six tubercles on the central node, but the larger ones do not. Those in the subdermal region are smaller than others in the subgastral; the former measuring 130–170  $\mu$ , and the latter 175–213  $\mu$ , in diameter. The specimen spicule shown in Contrib. III., Pl. VI., fig. 16, is from the subdermal space. (In *S. dowlingi* the discoctaster diameter is known to be 228–320  $\mu$ , manifestly never falling below 200  $\mu$ ).

Spherical *microdiscohexasters* of 19  $\mu$  diameter and of the usual appearance are found very sparsely distributed in the endosomal layer. I consider that they require no special description.

### STAUROCALYPTUS AFFINIS NOV. SP.

Pl. XIII. and Pl. XIV., figs. 14, 16, 17, 22–25.

*Staurocalyptus Dowlingi* in part. IJIMA, '97, p. 53; '98, p. 53.

This new species is based on two specimens in the Science College Museum, which were at first—erroneously, I now think



—taken by me for *S. dowlingi*. This would suggest its close resemblance to that species and also to *S. tubulosus*, a fact which can not be gainsaid. The two specimens differ in certain points of outward appearance but show an essential or almost complete agreement in spiculation. Such differences as exist between them are manifestly referable to difference in individual age and partly also to the different state of their preservation; so that, I have scarcely a doubt as to their specific identity. I propose to call them *S. affinis*.

Each of the two specimens serves greatly to supplement the knowledge to be derived from the other. They will be separately described as regards their macroscopic characters.

The one I take up first (S. C. M. No. 194, from which all the figures in Pl. XIII. are taken), was purchased of a Misaki fisherman in 1891. The locality as put down on the label is Okinosé; depth not stated. The specimen consists of large and small dried fragments which must originally have formed the wall of a tubular or vase-like form, assumably about 300 mm. in height and not less than 100 mm. in diameter. The maximum thickness of the wall is about 9 mm. Owing to imperfect desiccation the texture is soft and loose, the tissues easily falling off in crumbs and shreds.

The external surface is much abraded. No lateral prostalia, which I presume were once present, are preserved. However, the delicate ectosome still remains here and there in small patches. It adheres closely to the choanosomal surface and consists of the usual dermal lacework supported by thin and irregularly intersecting hypodermal strands (see Pl. XIII., fig. 10). The dermal meshes, of approximately quadrate shape, are on an average about  $165\mu$  wide.

The external choanosomal surface (Pl. XIII., fig. 1) is tolerably even and presents a coarsely fibrous appearance. It exhibits variously sized, roundish, incurrent canalar apertures, the largest of which may measure  $3\frac{1}{2}$  mm. in diameter. The larger apertures are separated from one another by an interspace nearly as wide as themselves or even considerably wider. They lead into deep pit-like canals.

The gastral surface (Pl. XIII., fig. 2) is on the whole excellently preserved. On it there open numerous, closely set, roundish and sharp-edged excurrent apertures measuring not more than 2 mm. in diameter. Most of them open freely and directly into the gastral cavity without a covering endosome, similarly as in several species of the genus (*S. reperi*, *doulingi*, *tubulosus*, *solidus*). In many cases the apertures are provided with an iris-like rim. It is, however, a remarkable fact that a covering endosomal latticework is not entirely undeveloped. Such a structure is in fact to be found here and there in small irregular areas, some of which are to be seen in Pl. XIII., fig. 2. It consists of irregularly reticulate beams, mainly composed of diactinic hypogastralia and inclosing small angulate meshes. These meshes are open, not filled in by a continuous gastral lacework; they can easily be distinguished from the underlying canalar apertures proper by their position, small size and irregular shape. The above endosomal layer, so far as it is distinctly differentiated, greatly resembles in appearance that of *Acanthascus cactus* (Pl. XI., fig. 16).

No diactins are found that project their ends through and beyond the gastral surface except such occasional cases as may be regarded as due to unnatural displacement.

The loose feltwork of the parenchyma contains a quantity

of coarse strands, running more or less parallel to the surfaces but otherwise in all directions (Pl. XIII., fig. 1). Especially coarse is its appearance on the external side of the wall. Picked up by means of a pincette the strands easily come off in strips often as long as 40 or 50 mm. At the torn edge of the wall the fibers bristle out in a conspicuous manner.

The second specimen (S. C. M. No. 400, shown in Pl. XIV., fig. 14) was obtained by KUMA in the Uraga Channel (Nago Hill- $\ominus$ Daibusa Spit and about 4 kilom. off the latter). It resembles a tube which laterally is slightly and irregularly compressed. It is 103 mm. long, 24–27 mm. broad in the middle and considerably broadened at the lower end. At one corner of the latter there is a small stalk-like base for attachment. At the opposite corner the wall is outbulged and thinned out at the top, apparently in the first stage of the breaking through of a secondary osculum. It is to be noticed that both this outbulging and the attachment base lie in the sagittal plane of the body, as is the rule with so many other Acanthascinae with similar parts. The upper truncated end of the body is taken up by an oval-shaped osculum. The wall is about 6 mm. thick in the inferior part, gradually becoming thinner towards the oscular edge.

From all over the external surface, except near the basal stalk, there arise both oxydiaetic and oxypentaetic prostalia lateralia. The prostal diaetics are not very numerous; they are long needles that spring out isolatedly to a length of 30 mm. or less, directed obliquely outwards and upwards. In the upper part of the body they are finer and much shorter than those situated lower down. Along the oscular edge they project straight upwards, the exposed portion not exceeding 4 mm. in length.—The large prostal

pentactins, either isolated or in loose tufts, arise from the top of small papilla-like prominences of the dermal surface, situated at intervals of 1–2½ mm. The pentactins, wherever they have escaped the influence of abrasion, are so numerous and crowded together that they form a gauzy layer of 3 or 4 mm. thickness over the dermal surface.

The latter is tolerably smooth except for the above-mentioned papillæ. Close beneath the thin ectosomal layer are seen the roundish apertures of the incurrent canals, which, in the lower part of the sponge, may measure up to 1½ mm. in diameter. The smallness of the canals in comparison with those of the first specimen seems to be sufficiently accounted for by the much smaller size of the individual.

The characters of the gastral surface are essentially the same as in the first specimen. Namely, while most excurrent canalar apertures are freely open, certain others are covered over by an irregularly meshed endosomal latticework. A number of small oxydiactinic parenchymalia are seen to project their fine ends beyond the gastral surface to the extent of about 1 mm. or more.

Taken all in all, the general appearance of the species is closely similar to that of both *S. dowlingi* and *S. tubulosus*, but especially of the latter. With our present knowledge it would be unsafe to pick out this or that macroscopic character in the above description of the specimens as in any degree distinguishing the species from either of the two just mentioned. It may further be stated that the spiculation, so far as the kinds of spicules entering into it are concerned, is to a great extent, if not essentially, the same in all the three species (to which I may add *S. entacanthus* n. sp. as a fourth). Nevertheless, there exist

certain points of difference shown by several of their spicules, that seem to warrant the separation of *S. affinis* as a distinct species.

### Spiculation.

The following description applies to the first specimen (S. C. M. No. 194; Pl. XIII.), unless the other specimen (S. C. M. No. 400; Pl. XIV., fig. 14) is explicitly referred to.

The *principal parenchymalia* are oxydiactins of unusually large dimensions, often 35 mm. or more in length and  $600\mu$  in thickness in the middle. (A portion of one is seen in Pl. XIII., fig. 12). They occur in great abundance, especially in the periphery of the choanosome. They are entirely smooth, tapering gradually towards both finely attenuated and sharply pointed ends. They are slightly wavy or else are bent either in a bow-like or in a boomerang-like manner. Diactins of gradationally intermediate shape and dimensions lead over the principalia to filamentous comitalia of only  $12\mu$  or less in thickness.

In the second and smaller specimen the principalia attain a length of 25 mm. and a breadth of  $520\mu$ .—It may be remarked that in no other *Staurocalyptus* species are the parenchymal elements known to develop such length and coarseness.—The needle-like prostal oxydiactins which were found only in the second specimen may be 40 mm. long and  $180\mu$  thick.

The diactins which join in the formation of *hypodermal strands* are mostly short, having a length of 1–2 mm. and a breadth of  $14\text{--}33\mu$  at the middle, where they may show a slight annular swelling. The ends are rough, somewhat tapering and obtusely or conically pointed,—not swollen as in the much longer



parenchymal comitalia. The diactins run sometimes singly but more usually a few are combined into thin bundles.

The *hypogastral diactins*, likewise running singly or in loose strands (see Pl. XIII, fig. 11), are similar to the hypodermal.

The *oxypentactinic hypodermalia* (to be seen in Pl. XIII., fig. 12) are large spicules with smooth, nearly straight or slightly bent rays. The paratangentials are in most cases more or less distinctly paratropal, but sometimes regularly cruciate. Their length measures 7–12 mm. and their thickness at base, about  $100\mu$ . The unpaired proximal ray is longer; it is accompanied by numerous thin comitalia (about  $9\mu$  thick) of the usual character.

In the second specimen I find the hypodermal (and also the prostral) oxypentactins somewhat smaller, the paratangentials measuring mostly between 5 and 6 mm. in length. Nevertheless it may be said that the spicule in question is on the whole considerably larger in the present species than in either *S. dowlingi* or *S. tubulosus*. Decidedly larger does it seem to be than in the former species, in which the paratangentials are said not to exceed 2.2 mm. in length.—The paratangentials of those pentactins already protruded as prostalia remain smooth in most cases. Only occasionally have I met with such prostral pentactins as have slightly rough or granular paratangentials. The roughness is here due to the presence of rounded and inconspicuous microtubercles somewhat like those in *S. dowlingi* but unlike the same in *S. tubulosus*.

The *dermalia* (Pl. XIII., fig. 3) are nearly exclusively pentactins; rarely and exceptionally, stauractins. The paratangentials are nearly straight or very slightly arched. All the rays are rough throughout; they generally taper perceptibly outwards



to terminate with rounded tips. Their length as measured from the spicular center is 130–200  $\mu$ ; on an average, 160  $\mu$ ; breadth close to base, 11–15  $\mu$ . In the second specimen the length was 100–170  $\mu$  or on an average 130  $\mu$ ; the breadth, 7½–10  $\mu$ .—The dermal paratangentials form a tolerably regularly quadrate-meshed dermal lacework (Pl. XIII., fig. 10).

The *gastralia* (Pl. XIII., fig. 4) are hexactins with similar but often longer rays than those of the dermalia. Length of rays, 140–240  $\mu$ ; in the smaller specimen, 140–175  $\mu$ . The free proximal ray is not distinguished from the others by a greater length. The gastralia are present in far too sparse a number to form a continuous lacework by themselves (Pl. XIII., fig. 11). They are found in irregular distribution in the spaces between the excurrent canalar apertures as well as on the endosomal reticular beams, where these are developed.

The *oxyhexasters* (Pl. XIII., figs. 7 and 9; Pl. XIV., figs. 16 and 17) measure 130–152  $\mu$  in diameter (in the second specimen, 115–160  $\mu$ ). They are exceedingly numerous both in the choanosome and the endosomal layer. While in the former the hexactinose and the hemihexactinose forms predominate, in the latter region the normally developed form is by far the most abundant.

The normal oxyhexasters, occurring in the endosome or in its proximity (Pl. XIII., fig. 9; Pl. XIV., fig. 16), show two or sometimes three, generally smooth, nearly straight and widely divergent terminals to an excessively short principal. The central node is often spherically swollen, but not sharply demarcated from the principals.

In the subdermal space, oxyhexasters are altogether sparse and those that do occur there are as a rule again normally

shaped. They are on the whole slightly smaller and more slender-rayed than in those in or near the endosome; besides, the terminals are always more or less distinctly rough (Pl. XIV., fig. 17). The roughness is in many cases plainly attributable to minute and inwardly directed barbs, especially distinct in the basal parts of terminals.

Hemihexactinose forms of the oxyhexaster most commonly show one or two uniterminal principals, the rest of the principals being each in possession of two terminals as is usually the case. The terminals are nearly straight and more or less rough-surfaced.

Hexactinose oxyhexasters (Pl. XIII., fig. 7) have likewise rough rays which are however frequently not quite straight but somewhat wavy. They are quite numerous in the choanosome, a fact which may perhaps be regarded as constituting one of the peculiarities of the species.

Occasionally I have met with interesting exceptional forms of the oxyhexaster, in which the hexactinose character is still further modified into the pentactinose and even the stauractinose by a complete suppression of the terminals on one or more of the principals. The principals, thus deprived of their terminals, remain in their position as smoothly rounded off prominences which leave no room to doubt that the terminals have not been lost by mechanical breakage but were undeveloped from the first. The above, evidently abnormal, forms were not noticed in the second specimen. In this, on the other hand, I have not infrequently met with the small rudimentary-looking spicules shown in Pl. XIV., fig. 22. These contain a small axial cross of filaments and there can be no doubt about their being oxyhexasters with terminals but little developed, though it is difficult to decide whether we have to do with early developmental stages or with abnormal appearances.

The *discoctasters* occur in the subdermal space as well as near the gastral surface. They are not very abundant, though in places several are found together. Right in the choanosome they must be very rare, if indeed they are ever present. Two sizes are distinguishable according to their position. The smaller discoctaster form (Pl. XIII., fig. 5), measuring 120–200  $\mu$  (in the second specimen, 160–183  $\mu$ ) in diameter, occurs only in the subdermal space; while the larger (Pl. XIII., fig. 6) of 280–400  $\mu$  (in the second specimen, 350–380  $\mu$ ) is confined to the proximity of the gastral surface. The range of variability in the size of discoctasters is here decidedly wider than in either *S. dowlingi* or *S. tubulosus*.

As to general shape the discoctasters in general closely agree with those of several other nearly allied *Staurocalyptus* species and also with those of *Acanthascus cactus*. The principals take up  $\frac{1}{3}$ – $\frac{2}{3}$  of the entire ray-length, are unevenly contoured, thicken somewhat in the outward direction and carry a slightly expanding tuft of 3–7, straight or nearly straight terminals. The central node, especially that of the smaller discoctasters, frequently shows the six well-known tubercles. In the larger form, the distal portion of the terminals is beset with minute but distinct barbs (fig. 6) and the terminal disc exhibits a number of marginal teeth exactly as I have figured them from *Acanthascus cactus* (Pl. XII., fig. 28). In the smaller form, the terminals are simply rough and the terminal discs pinhead-like.

The discoctaster as well as the oxyhexaster,—of the latter, both the normal and the hexactinose forms,—I have subjected to special examinations in order to determine the position and extent of the central cross of axial filaments in the central node. The results are embodied in Pl. XIV., figs. 23–25, which will speak

sufficiently for themselves, so that comments upon them may here be dispensed with.

*Microdiscohexasters* (Pl. XIII., fig. 8) of spherical shape and 19–20  $\mu$  diameter are not uncommon in or near the endosomal layer. They were occasionally observed in the ectosome also. From a spherical node arise comparatively thick principals, which in length are about  $\frac{1}{2}$  the radius of the rosette and each of which carries at the outer end a small disc, usually provided with a central tubercular prominence on the external side. The terminals are exceeding fine and difficult to count, but probably not more than 10 to each principal.

Finally, the *basidictyonal plate*, found preserved in the second specimen, is rather thick and consists of an irregular reticulum of beams of variable thickness (up to 30  $\mu$ ), inclosing mesh-like spaces up to 100  $\mu$  in width. The beams are beset with small prickles as well as with larger conical protuberances. Here and there can be observed hexradiate axial crosses in the nodal points. Also some rough and thick-rayed hexactins are seen in the first process of being amalgamated with the basidictyonal beams. Pl. XV., fig. 12, taken from *S. glaber*, equally well illustrates the condition of the basidictyonalia in the present species.

The chief points in the spiculation of the present species, requiring special attention in relation to such other species as are most likely to be confounded with it, seem to be: the great length and coarseness of the principal parenchymalia; the large size of prostal pentaetins, in which the paratangentials are in

most cases smooth but occasionally slightly granular ; the comparatively large size attained by gastral hexactins ; the great abundance of hexactinose oxyhexasters ; and the wide range ( $120\mu$ – $400\mu$ ) of variation in the size of discoctasters as well as their large maximum size. (For a comparative table of the main distinctive features of this species and of certain others, see the foot-note on pp. 166–167).

**STAUROCALYPTUS ENTACANTHUS** NOV. SP.

Pl. XIV., figs. 15, 18.

*Staurocalyptus Dowlingi* in part. IJIMA, '97, p. 53 ; '98, p. 53.

The specimen which I now make the type of this new species is another that was at first placed by me under *S. dowlingi*. Its characters were therefore taken into account in drawing up the diagnosis of that species given by me in '97.

The said specimen (Pl. XIV., fig. 15. S. C. M. No. 242) comes from the north of Onigase and from a depth of between 429 and 572 meters. It is a large piece of wall torn from the superior end of an individual, which when entire must have had a sac-like or vase-like shape with a diameter of nearly a foot. It exhibits a part of the natural oscular edge, which is sharply angular but not thin. The marginal zone, is divided into a number of broad triangular flaps, folded outwards and backwards and even partially rolled up, so that in places the oscular edge is in touch with the dermal surface of the lateral wall. Between



each two of the flaps there remains in the oscular edge an unreflected point; consequently there arises at each such position an ear-like projection, which is all the more prominent since the edge of reflection of the flaps on its either side is depressed so as to present a concavity directed upwards. There are three such ears in the fragment on hand, measuring 105–145 mm. from tip to tip of two adjacent ears. In the entire state of the individual there must have existed at least seven ears and as many reflected flaps around the superior opening of the gastral cavity.

The wall is 13 mm. thick at a point about 100 mm. below the tip of the ears and must have been thicker towards the sponge-base.

The state of preservation of the specimen which has been dried, is as good as could be desired. The dermal surface is tolerably smooth, distinctly showing the delicate, regularly quadrate-meshed dermal lacework and the irregularly meshed hypodermal network. On close observation, the thin fibers composing the latter are seen to be so arranged as to present numerous radial figures, the centers of which are  $2\frac{1}{2}$ –6 mm. apart from one another. Pentactinic prosthelia of medium size are found only on parts of the external surface that are protected from abrading influences by the folding of the marginal flaps. They are irregularly distributed, usually solitary and project to the length of at most 3 mm. Except a few isolated and quite insignificant needle-like spicules springing out on the sharp oscular edge, no diactinic prosthelia are present. Presumably, however, the species in a young stage of growth is provided with a greater quantity of both pentactinic and diactinic prosthelia.

The larger apertures of incurrent canals, vaguely visible



through the dermal layer, may be 3 mm. wide, and that in a position not more than 100 mm. distant from the uppermost end of the specimen. In the interspaces between the apertures the ectosomal layer is in tolerably close contact with the choanosomal surface.

The gastral surface, so far as this extends in the specimen, is entirely lined with a well-developed endosomal latticework, which is for the most part very distinctly set apart from the underlying choanosome and covers up all the excurrent canalar apertures (up to 3 mm. dia.), in a measure concealing these from view. Its appearance is not unlike that of the same structure in *S. affinis*, in which species, however, it is developed in but small irregular patches and not all over the gastral surface. The endosomal beams, the main support of which is afforded by strands of hypogastral diactins, are of a moderate strength and inclose small, irregularly shaped meshes (mostly  $\frac{1}{2}$ – $\frac{3}{4}$  mm. wide), which are open and not filled in by a continuous lacework of gastralialia, unlike those in *S. fasciculatus* but quite like the same of *Acanthascus cactus* (see Pl. XI., fig. 16). This endosomal latticework, probably developed over the entire gastral surface and leaving none of the excurrent canalar apertures quite freely open, may be regarded as one of the distinctive features of the present species as contrasted with many closely related forms in the same genus.

Another noteworthy, and I think characteristic, point in the features of the gastral surface is the fact that numerous, moderately strong oxydiactins project freely beyond the surface, mostly to a length of 4 or 5 mm. There is no rule as to the direction of the projecting needles, which occur over the entire gastral surface so far as this is represented in the fragment, but

somewhat more abundantly in the region of the reflected marginal flaps than lower down. They give to the gastral surface a peculiarly hispid or spiny appearance, an idea of which may be obtained from the appearance presented by the upper border of fig. 15, Pl. XIV. Similarly disposed needles are known to me to occur on the gastral surface of *S. tubulosus* and *S. affinis*; but in both these species their trichodal ends project to so short an extent that their effect upon the surface is to render it at most delicately hairy. *S. dowlingi* also seems to be not altogether devoid of needles protruding from the gastral surface; but here, F. E. SCHULZE ('99, p. 49) was led to regard them as something of occasional and rather accidental occurrence; while L. M. LAMBE ('93), in his description of that species, says that the gastral surface is smooth, and makes no mention of projecting needles. Now, in the present species, the needles in question are spicules, coarse rather than fine and of a considerable length, and moreover so abundant that they can not fail at once to attract one's attention; and in view of the well-preserved state of the tissues, I see no reason for not assuming that we have here to do with a normal character, probably constant to the species.

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Here I may interpolate an account of a specimen which I provisionally refer to *S. entacanthus* but with a query. While agreeing as regards many characters with the above-described type-specimen, it shows several points of difference, especially in regard to the spiculation,—differences, which, on further study with more material, may possibly turn out to be of more than individual value.

The specimen in question (S. C. M. No. 403) was obtained at Inside Okinosé by the Iwado-line from a depth of 618 m.

Two views of it have already been published in my Contribution III., Pl. VI., figs. 9 and 10. Appended to them will be found the name of *S. japonicus*, an appellation which I beg herewith to withdraw.

The specimen is the upper portion of a thick-walled and probably tubular or cylindrical individual. It is about 62 mm. long by 42 mm. diameter; the wall is 9 mm. thick in the thickest part. While the gastral cavity is nearly cylindrical throughout, the external surface curves in at the top forming a rather thick oscular edge. The osculum is irregularly roundish with a diameter of 22-24 mm. I presume that pentactinic prostalia in tufts, were originally present but have been lost by breakage, for there exist stumps of what appear to be their shafts arising in association with small papilla-like prominences of the dermal surface, which is on the whole tolerably smooth. The said prominences occur on the average at intervals of about 3 mm. Of diactinic prostalia some remnants seem to be represented by a few, fine and isolatedly projecting needles. The apertures of the larger incurrent canals reach up to nearly 2 mm. in diameter; those of an approximately similar size are separated from one another by an interspace usually wider than their own diameter. Over this interspace the thin and delicate ectosomal layer is closely adherent to the choanosome.

The endosomal layer, closely similar to that of the type-specimen (*i.e.*, consisting of a small and irregularly meshed lattice-work, in which the meshes are not filled in by a dermal lacework but remain open), is well differentiated over the entire gastral surface. Accordingly, no excurrent canals can be said to open freely and directly into the gastral cavity. Not only in this respect does there exist an agreement with the type-specimen

but also in the strikingly and densely hispid character of the gastral surface (see Contrib., III., Pl. VI., fig. 9). This is caused by numerous projecting needles of a moderate strength, occurring from the oscular edge downwards over the entire gastral surface of the specimen. They are firmly implanted in the sponge-wall, their inner ends protruding 5 mm. or more, sometimes vertically but more usually inclined in indefinite directions. It is entirely beyond question that the spiny character of the internal surface is not accidental but natural.

The spicules of this specimen will be specially dealt with after I shall have described those of the type-specimen in the following paragraph.

### Spiculation.

First, that of the type specimen (Pl. XIV., fig. 15).

The *principal parenchymalia* are oxydiactins which may attain a length of 9 mm. and a breadth of  $250\ \mu$  in the middle. They are relatively thick, nearly straight but sometimes bow-like or boomerang-like spicules; entirely smooth and not very much attenuated towards both sharply pointed ends. Small and finer parenchymalia are of the usual characters.

The needles projecting from the gastral side are oxydiactins similar in appearance to the principal parenchymalia. They may be 9 mm. long and  $90\ \mu$  thick. A varying number of fine comital diactins are found accompanying them.

*Hypodermal oxyptentactins* are mostly found several together in loose groups, in which the smaller and therefore younger ones are always more deeply situated than those of older formation.

When fully grown, the paratangentials, which are either paratropal or regularly cruciate, measure 4 mm. in length and  $65\mu$  in thickness at base. They may acquire a rough surface, due to rounded microtubercles, while still remaining in the hypodermal situation. But this apparently does not take place in all cases, for among the oxypentactins already protruded as prostalia I have found some with rough and others with perfectly smooth paratangentials.

Diactins also enter into the composition of the hypodermal strands though not in large numbers. These hypodermal diactins are somewhat variable in size and characters. While the larger of them are indistinguishable from ordinary parenchymalia, others are small, tubercled around the center and rough all over instead of being so at the ends only. The latter kind might easily be taken for dermalia, were it not for their association with unmistakable hypodermal elements.

The *hypogastralia* are diactins similar to those of the hypodermal strands.

The *dermalia* and *gastralia* may be said to be essentially like those of *S. dowlingi*, *tubulosus* and *affinis*.

On the pentactinic dermalia, which are by far the predominant form, I have frequently observed a low prominence in the place of the aborted distal ray. Length of rays, 130–200  $\mu$ . Rarely stauractins and still more rarely diactins are met with among the dermalia.

With respect to the hexactinic gastralia, it may be mentioned that these are on the whole somewhat smaller than the same spicules in either *S. tubulosus* or *affinis*, agreeing closely in this respect with *S. dowlingi*. Length of rays, 95–130  $\mu$ .

The *oxyhexasters* measure 100–132  $\mu$  in diameter, thus coming next in size to the same rosette in *S. dowlingi* and *tubulosus*. A goodly number of them are hemihexactinose, but I have found none in quite hexactinose form. This negative character may perhaps be regarded as one of the peculiarities of the species, or at any rate of the particular specimen now being described. The terminals are rather strong (often 4  $\mu$  thick at base),—stronger than I have found them to be in other closely similar species of the genus. Moreover, they are always rough, the roughness being frequently developed into short barbs on the basal parts.

Of the *discoasters*, those in the subdermal space measure 155–220  $\mu$  in diameter; those in or near the endosome, 220–286  $\mu$ . It may be pointed out that the lower limit (155  $\mu$ ) in this range of variation falls considerably below that in *S. dowlingi* (228  $\mu$ ) but coincides in an approximate way with the same in *S. tubulosus* and *affinis*. In all of the discoasters the principal is somewhat shorter than, or sometimes nearly as long as the terminal tuft belonging to it. The general appearance of the spicule agrees well with that of the same in *S. affinis*. In no case, however, have I noticed the six prominences on the sides of the central node.

*Microdiscohexasters* I have failed to discover anywhere in the specimen; but, in view of the ease with which they might be overlooked, I am not fully prepared to assert their total absence.

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Now let me describe some points in the spiculation of the smaller specimen (No. 403; Contrib., III., Pl. VI., figs. 9 and



10), provisionally referred by me with some degree of hesitation to *S. entacanthus*.

Here the principal parenchymal oxydiactins attain a maximum size of 15 mm. length by  $80\mu$  breadth. Thus they may be longer and decidedly more slender than in the type-specimen. Another appreciable point of difference consists in the more gradual manner of tapering towards both ends which are slender and more or less rough-surfaced.

The oxydiactins protruding from the gastral surface may be 20 mm. long and  $250\mu$  broad in the middle. They are much longer and thicker than the corresponding spicules in the type-specimen. This fact seems noteworthy especially when the smaller size of the specimen under question is considered.

Among the dermalia I have found, though exceedingly rarely, regularly developed hexactinic forms. In many of the dermal pentactins the distal ray is represented by a mere knob.

The different kinds of hexasters are quite similar to those of *S. affinis*.

Oxyhexasters are normal, hemihexactinose or hexactinose. The last mentioned form is numerous represented, and constitutes another notable point of difference from the type-specimen. Diameter, generally  $120-186\mu$ ; the hexactinose form may be larger, sometimes attaining  $242\mu$  in axial length.

Peripheral discoctasters,  $143-176\mu$ ; those deeply situated,  $262-352\mu$ , rarely up to  $428\mu$  in diameter. The upper limit in the size of discoctasters seems to extend very considerably over and beyond that determined for the type specimen.

Microdiscohexasters of spherical shape and  $19\mu$  diameter are occasionally found in the endosome.

### Soft Parts.

Care was taken by KUMA, the collector, to preserve in strong spirit small pieces from both the specimens described above; so that I have been able to make some studies on their soft parts. This however has yielded no special additions to the knowledge we already possessed. I therefore restrict myself to recording only a few points.

The thimble-like and sometimes cup-like chambers were observable with especial distinctness in the specimen (No. 403) referred tentatively to *S. entacanthus*. Here they have a diameter of 110–187  $\mu$  (on an average, 155  $\mu$ ). The usual reticular structure of the chamber-wall is in places very beautifully shown (Pl. XIV., figs. 20 and 21). The meshes, the open nature of which can not be doubted, measure about 5  $\mu$  in length of sides. Observed under the immersion system, every nodal point is seen to be occupied by a vesicular, not specially well-stained nucleus, 1.7–3.4  $\mu$  in diameter and containing some chromatic granules. The smaller nuclei present a more compact appearance than those of a larger size. In optic sections of the wall, the nuclei have a distinctly oval outline.

In both specimens the trabeculae are frequently spread out in the form of a membrane especially on the surfaces which come in contact with the external world,—not only on the dermal and gastral sides but also along the lumen of the larger canals. The finely granular substance of trabeculae may exhibit in the film-like parts somewhat deeper-stained and often irregularly branched streaks, which in some places may run more or less parallel to the edge of the film-like plate (Pl. XIV., figs. 18 and 19). The first thought on observing them would likely be that we have

here to do with a fibrillar structure. But by close observations I have come to the belief that the streaks do not represent fibrils actually developed as such but are merely wrinkles or irregularities in the thickness of the film. One strong reason in support of this view is the fact that the streaks are frequently quite ill-defined as to their contour and may, at one place or another, pass over gradually and insensibly into the general substance of the film. They are in part probably the effect of shrinkage or contraction, such as might be caused by the action of reagents or by protoplasmic activity in the living state; the rest are to all appearance simply the terminations of those filamentous trabeculae which have just reached the film-like portion in order to join it.

In certain places it seemed to me that the spaces between the trabecular nuclei ( $2-2\frac{1}{2}\mu$  large) were unusually wide.

The thesocytes are of a somewhat different appearance in the two specimens.

In the type specimen of *S. entacanthus*, they are conglomerate-like in that the contents consist of a group of variously sized spherules (Pl. XIV., fig. 18). These are usually deeply stained but not always to the same intensity. Their substance is nearly homogeneous or shows a faint granulation. In many cases the contents appear to be in the process of breaking up and becoming resorbed. The nucleus evidently lies concealed among the spherules.

In the other specimen (*S. entacanthus*?) the thesocytes have moderately well-stained protoplasm-like contents which are rather coarsely granular (Pl. XIV., fig. 19), instead of being composed of spherules in conglomeration. The nucleus is distinctly visible as a dark spot. The cells are roundish or oval in shape with a diameter of  $20\mu$  or under. A delicate enveloping membrane can often be distinctly made out. I have found the cells in abundance

on the dermal and subdermal trabeculae as well as on those around the lumen of the larger incurrent canals, but none in any part of the trabecular system of the excurrent side.

### STAUROCALYPTUS MICROCHETUS\* IJ.

Pl. VIII., figs. 17-25.

*Staurocalyptus microchetus*. IJIMA, '98, p. 53.

The single type-specimen of this species (S. C. M. No. 450) is from Outside Okinosé by the Iwado-line (about 572 m. depth). It is attached to a piece of rust-colored, easily breakable tuff.

The body represents a rather thin-walled, laterally compressed tube, gently and slightly outbulged between the two ends (see Pl. VIII., fig. 17). It is attached at the lower end by a tubercular base and also by an accessory base a short distance above the first. Total height of the specimen, 95 mm. Breadth at the middle, 37 mm. by 23 mm. Thickness of wall in that region, 3 mm. The simple-edged, wavy oscular rim is directed straight upwards.

A veil covers the entire external surface. It is by no means conspicuous, because the pentactinic spicules composing it are very small and project only about 1 mm. or less beyond the smooth dermal surface. Here and there a few, short and very fine needles are seen standing out from the external surface in the manner of diactinic prostalia, which probably they really are.

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\* μικρός, and όςςςς canal.

The wall is tolerably firm on account of the closely interwoven state of the parenchymal spicules as well as of the small size of the canals. These, both incurrent and excurrent, are never so large as to measure 1 mm. across. Their apertures lie close together and are indistinctly visible through the tissues (ectosomal or endosomal as the case may be) immediately above them.

The gastral surface, like the dermal, appears smooth and uniformly compact. Some parenchymal needles are seen to project into the gastral cavity but not in considerable numbers.

I may say that the essential microscopic characters of the sponge are quite unlike those of any other *Staurocalyptus* known to me, so that they alone should in my opinion suffice to prevent the species being confounded with any other in the genus.

### Spiculation.

Some *parenchymal diactins*, evidently the principalia, are comparatively very large. They may be as long as 24 mm. with a thickness of  $143\mu$  in the middle. Such large diactins are invariably without a central swelling; they gradually taper towards both ends which are nearly smooth or only slightly rough. The smaller parenchymalia and the comitalia are of the usual characters.

The *hypodermal pentactins* (seen in Pl. VIII., fig. 24) are isolated, not in groups. In relation to this fact the four paratangentials always are regularly cruciately, and not paratropally, disposed. They are nearly straight or only slightly bent, measuring up to  $1\frac{1}{2}$  mm. in length and  $32\mu$  in breadth at base. The

unpaired proximal ray may be twice as long as the paratangentials in the same spicule. In most cases all the rays are smooth except for a sparse number of obsolete microtubercles near their conically pointed or rounded tips. However, some of the spicules—without doubt those that are old and ready to be protruded as prostalia—show paratangentials which are entirely rough, this being due to a thick covering of minute processes similar to those I have observed on the corresponding spicules of *Scyphidium longispina* (Pl. II., fig. 3). On the other hand, among those pentactins already protruded from the dermal surface as prostalia, I find some with paratangentials roughened in the manner just mentioned but others exhibit no trace whatever of such roughness. Thus, it seems that this roughness may possibly never appear on some of the pentactins, though under certain circumstances it develops while the spicules are still hypodermally situated.

The *dermalia* (Pl. VIII., fig. 18) are generally stauractins; exceptionally pentactins. The former are nearly flat or just perceptibly arched. The latter have the unpaired ray directed proximad. The rays are strongly prickly all over, gradually tapering from the base towards the pointed end. Length of rays, 75–100  $\mu$  (on an average 85  $\mu$ ). Their average thickness at base, 9  $\mu$ . The arrangement of the spicules in their relation to one another is rather irregular (see Pl. VIII., fig. 24), though here and there an approach towards forming quadrate meshes is observable.

The *gastralia* (Pl. VIII., fig. 19) are hexactins with rays characterized similarly as in the dermalia. All the rays in the spicule are generally about equally long, though sometimes the



free proximal ray is found to be somewhat longer than any other of the six. Length of rays, 120–143  $\mu$ ; average thickness at base, 10  $\mu$ . The spicules form a continuous lacework which is for the most part regularly quadrate-meshed (Pl. VIII., fig. 25). It lies close over the parenchymalia, from which scarcely any diactins can be distinguished as hypogastralia.

The *oxyhexasters* may be distinguished as of two kinds, though these seem to intergrade into each other by transitional forms. They may be said to differ in respect both of size and general appearance.

One kind (Pl. VIII., fig. 21) is met with, not abundantly but in moderate frequency, only in the proximity of the ectosome. It is comparatively small and of a delicate appearance. Diameter, 68–100  $\mu$ . From each short and slender principal there arise 3–5, thin and widely divergent terminals.

The other kind (Pl. VIII., fig. 20) occurs in the choanosome as well as in the endosome and is far commoner. Besides being larger, the terminals are somewhat stronger and the principals usually so exceedingly short that they may be called abortive. Diameter, 106–136  $\mu$ . The central node is frequently swollen to a globular shape. The number of terminals to a principal is usually 2, but may rarely be 3 or sometimes only 1. Hemihexactinose forms are of occasional occurrence. Hexactinose forms were not found; if they occur at all, they must be very rare. The terminals are nearly smooth or obsoletely rough.

The *discoactasters* (Pl. VIII., fig. 23) are very abundant subgastrally and apparently also in the endosome itself. I have not found them in any other position. Diameter, 114–128  $\mu$ .

The central node is provided with the six tubercles which are moderately prominent. The secondary principal measures in length between  $\frac{1}{2}$  and  $\frac{1}{2}$  that of the entire ray. The number of terminals to each principal may be put down at 5-10, but is more usually 8-10. The terminals appear to be rather strong; at any rate they cannot exactly be called fine. The tuft they form is about  $10\mu$  broad at base and may expand to thrice that breadth at the outer end. Each terminal gently bends slightly outwards in its course towards the thinly attenuated end, which is furnished with a pinhead-like terminal disc.

The *microdiscoherasters* (Pl. VIII., fig. 22) seem to be very sparse; in fact they were met with only in a few isolated cases, in what part of the wall I can not definitely state. Diameter 23-26  $\mu$ . The terminals are exceedingly fine and not very numerous. They give a spherical shape to the entire spicule. The principals may be simply knob-like as shown in the figure; but this is not always the case; for, in some specimens of the spicule I have seen each short principal furnished with the usual terminals-bearing discs at their outer ends.

Finally, the *basidictyonal* plate. This I have isolated in small fragments from the attachment surface. In these I have made out that the single spicules, which by amalgamation go to constitute the plate, are mainly stout stauractins and occasionally pentaactins. The rays in these spicules may be as thick as  $15\mu$ , their surface showing microtubercles in moderate numbers. The fact that these spicules are not hexactins as is the rule with dictyobasalia in general, probably has some connexion with the thinness of the plate in the present case.

## STAUROCALYPTUS GLABER IJ.

## Pl. XV.

*Staurocalyptus glaber.* IJIMA, '97, p. 57.

This species seems to be not altogether uncommon in the Sagami Sea. More than a dozen specimens, representing various stages of growth, have been examined by me. The exact localities they came from are: Maye-no-Yodomi, in depth between 501 and 572 m. (=274 and 317 fms.); Inside Okinosé by the Sengenzuka-line, about 500 m. (=274 fms.); Outside Okinosé by the Iwado-line, about 480 m. (=262 fms.); Homba, between 501 and 572 m. (=274 and 317 fms.); etc.

In some specimens the sample of the bottom attached to the base is of a tufaceous nature, but the majority are attached to dead remains of other Hexactinellids, such as *Periphragella elisæ*, *Chonelasma calyx*, *Hexactinella lorica*, *Farrea* sp. and *Hyalonema* sp. On that most remarkable *Chonelasma calyx* which I have mentioned on p. 25 and figured on p. 31 of my Contrib. I., a small specimen of the present species was found in association with *Chaunoplectella cavernosa* and *Rhabdocalyptus capillatus*.

To mention some of the representative specimens in particular. The largest specimen I have seen was of a laterally compressed, vase-like shape, measuring 250 mm. in height, 66 mm. by 95 mm. broad at about the middle and 17 mm. in thickness of wall in the same part. The specimen was in a bad state of preservation.

In Pl. XV., figs. 1 and 2, are shown in half natural size

two exquisite specimens in the possession of the Sci. Coll. Museum.

The individual of fig. 1 (Mus. No. 244) represents a thick-walled vase, slightly laterally compressed, rounded above and narrowed towards the base by which it is attached to the side of a dead *Periphragella elisæ*. Entire height, 109 mm.; breadth in the broadest part, 47 mm. by 64 mm.; thickness of wall in the same part, 14 mm. Somewhat on one side of the upper end is situated the roundish osculum, 27 mm. in diameter. A sparse number of inconspicuous proctal diactins, protruding to a length of 14 mm. or less, is present, especially in the region adjoining the oscular margin.

That of fig. 2 is pouch-like and distinctly laterally compressed. Height, 130 mm. Breadth near the middle, 80 mm. in one direction and 54 mm. in another. Thickness of wall at about the middle, 14 mm. The osculum is of an oblong shape, being elongate in the sagittal line. The basal attachment is on one side of the inferior end. The sponge is therefore bent in the basal region, the bending being as usual in the sagittal plane of the laterally compressed body. Nearly opposite to the basal attachment there exist two small secondary oscula, situated close to each other. No proctalia of whatever sort are to be seen on the specimen.

Small, and therefore evidently young, specimens of the species are characterized by the possession of fine, but conspicuous, proctal needles.

The smallest specimen I have had was of a nearly globular shape, measuring only 6 mm. in height and with a roundish osculum of 2 mm. in dia. It showed a small number of fine proctal needles, apparently in the first stage of protruding outwards.

Much larger are the two young individuals shown in Pl. XV.,

fig. 3. They are both of an ovoid shape, growing side by side on a dead *Chonclasma calyx*. One is 38 mm. and the other 32 mm. high. The latter shows an osculum of 6 mm. dia. Fine and long prostal needles, springing out isolatedly and directed outwards and upwards, are present in moderate numbers. They occur more especially in the upper half of the body. Some of them may be 14 mm. long. From the constant absence of pentactinic prostalia and from the peculiarly cavernous appearance of the wall, I find it easy to distinguish the young of this species from those of certain other discoctasterophorous species, such as *Rhabdocalyptus victor* (Pl. XIX., fig. 17) and *R. capillatus* (Pl. XXII., fig. 3-5).

One more specimen (text-fig. 7) requires special mention as being highly remarkable in more than one respect. The sponge-body (64 mm. long and 27 mm. by 37 mm. broad in the middle) presents the appearance of running out basally into a root-tuft consisting of a number of strong needle-like spicules, instead of being firmly fixed to a hard substratum as in all other specimens of the species. F. E. SCHULZE (Chall. Rep., p. 41) conceived the idea that with differing conditions of the sea-bottom, it was possible for one and the same species to produce a root-tuft in one case and not in another. This



Text-fig. 7.

*S. glaber* growing on basal spicules of *Hyalonema* sp. (S. M. No. 361, obtained May 1895 at Outside Okinose).

assumption of F. E. SCHULZE's I at first thought had been actually realized in the case under consideration; but this proved to be simply an illusion, for by microscopic observations it could clearly be demonstrated that the tufted spicules at the basal end of the specimen do not belong to that sponge and are nothing

else than old and much lacerated, anchoring needles of a *Hyalonema* species,—presumably, of *H. affine*. The ends of the needles are invariably broken; some of them show the characteristic spines on the surface; and their surface, so far as it lies imbedded in the sponge, is covered with a thin siliceous reticulum, the same as the so-called basal-plate which is known to develop on the attachment surface of so many Hexactinellids firmly fixed to the substratum. It is then beyond dispute that the *S. glaber* in question had attached itself to, and was growing on, a tuft of *Hyalonema* needles.

Another very interesting fact in relation to the specimen under consideration is the presence in large numbers of certain, peculiar, small bodies lodged among the tissues of the choanosome. To these bodies I have already had occasion to refer in Contrib. I. (p. 186, foot-note) of this series of Studies. To the naked eye they appear as whitish spots of various sizes under 0.6 mm. diameter. Except in the ectosome and the endosome, they occur throughout the sponge in tolerably uniform distribution. Under the microscope the body is found to be a reticular mass of no definite shape; it consists of an irregular rigid framework of microtuberculate siliceous beams (Pl. XV., fig. 13). The mass is always traversed quite through by a few parenchymal diactins of the sponge containing it. It is further easy to make out that the aforesaid beams are formed by the soldering together of small but comparatively thick-rayed hexactins that exhibit no regularity as to their relative disposition. The hexactins (under  $100\mu$  in length, and  $10\mu$  in thickness, of rays) are in characters quite similar to those that go to compose the basidietyonal framework of the species (see Pl. XV., fig. 12). In fact, I have no hesitation in regarding the above described reticular bodies to be the



basidictyonalia belonging to quite young individuals of the species : it appears that a brood of the young had temporarily or otherwise settled themselves on, and had each formed its own basidictyonal framework around, the parenchymalia of the old specimen in question. It is impossible to do more than speculate as to the mode of origin of that brood of the young. But one point appears to me to be almost certain, *viz.*, that the reticular bodies treated of are the same as those described by F. E. SCHULZE ('99, p. 64 ; Pl. XIV, figs. 2-6) from the buds borne on the prostalia lateralia of *Rhabdocalypus mirabilis*. Seen in this light and from my point of view concerning the phylogenetic relation between the "Lyssacina" and the "Dictyonalia" (Contrib. III., pp. 23-25, foot-note), it seems to me readily explicable, if, in the development of a firmly seated lyssacine Hexactinellid, certain supporting spicules early underment ankylosis and thus acquired a dictyonine character.

But to return to the general characters of the species. Summarily speaking, we have here to do with thick-walled, saccular or vase-like, firmly seated forms, which, after attaining a certain size, are laterally compressed to a greater or less degree. Superiorly the wall somewhat closes in towards the sharp, but not thin, oscular edge. The young are ovoid in shape and are furnished with conspicuous, but slender and isolated prostal needles, which, after the full growth of individuals, seem to become entirely or almost entirely lost. Pentactinic prostalia do not occur in any stage of the life.

The dermal surface is moderately smooth. The delicate ectosomal skeleton consists of a minutely quadrate-meshed dermal lacework and of supporting hypodermal strands. The latter are

of various thicknesses but on the whole are thin. They run in somewhat curved courses and intersect with their fellows at various angles, thus forming meshes of very irregular shapes. Frequently a number of the strands are seen to radiate, though in an irregular manner, from the point where a pillar or pillars from the choanosme join the ectosome.

The endosome appears much like the ectosome. It lies closely applied to the internal choanosomal surface. The gastralial form a continuous lacework over the meshes bounded by the hypogastral strands which are on the whole somewhat thicker than the hypodermal.

Characteristic of all the specimens are the rather cavernous appearance, and the somewhat loose and light-looking texture, of the wall. The former character is due to the spacious development of the subdermal cavity and to the comparatively large caliber of the canals proceeding from it. The subdermal cavity is of a width known to me in no other Acanthascine species. In large specimens it may in some places be nearly 10 mm. wide. Conical or irregularly ridge-like projections—the pillars—join the choanosome to the ectosome. The spaces between such adjacent pillars vary in extent and may each contain sometimes a single and sometimes several large incurrent canalar apertures. These are round or oval, measuring up to about 7 mm. dia. in large individuals, and may be separated from one another by an interspace of 4 mm. or more.

The incurrent canals are not deep and pit-like, but rather shallow and funnel-shaped. This is probably in some way related to the wide development of the subdermal space, which not infrequently passes over into the canals without any perceptible demarcation. The apertures of branch canals opening into the primary canals are generally plainly visible from the outside.

Excurrent canalar apertures on the gastral side are on the whole much smaller and situated more closely together than the incurrent. The canals they lead into are deep and pit-like, unlike those of the incurrent system.

The *soft parts* (see Pl. XV., fig. 11) were studied by me but without results of any special interest. The limiting trabeculae of both the dermal and the gastral surfaces are to a great extent membranously developed. The free proximal rays of the gastralia heave up the gastral membrane in a tent-like manner. External trabeculae are most numerous present where the choanosome most closely approaches the ectosome. A large part of the wide subdermal spaces is quite free of them. Chambers, of the usual shape and appearance; 100–165  $\mu$  in diameter. Archaeocytes and thesocytes much as I shall later describe from *Rhabdocalypus capillatus* (Pl. XXIII.).

### Spiculation.

Pl. XV., fig. 11, will serve to give a general idea of the spiculation.

The *parenchymal principalia* are elongate spindle-shaped oxydiations with rough-surfaced ends and are more or less bent in a bow-like manner. They may attain a length of 13 mm. and a thickness of 190  $\mu$  in the middle. The smaller parenchymalia and the comitalia are of the usual characters.

The diactinic *prostalia*, present on the younger specimens, may be 25 mm. long or longer. In thickness they may measure

90  $\mu$ , but are usually thinner. The major part of the length is protruded free, while the part rooted in the wall is accompanied by fine comitalia.

The *hypodermalia*, which go to form the hypodermal strands, are pentactins and diactins, in both of which the rays are always smooth except at the roughened ends. The extreme tip of the rays is either rounded or conically pointed.

The hypodermal pentactins are of a large size. The curved or nearly straight paratangentials may be 8 mm. long with a breadth of 80  $\mu$  at base. The unpaired proximal ray, which is always straight, is much longer and is invested with fine comital diactins in the usual manner. This ray, together with the roots of the diactinic prostalia that may be present, forms a part of the so-called pillars. Seen on the sponge surface, the centers of hypodermal pentactins are situated either isolatedly or a few together in loose groups. Their loose arrangement sufficiently accounts for the fact that the four paratangentials in a spicule generally have a regularly cruciate disposition, each being free to take its natural direction during development (cfr. p. 131). Only occasionally have I met with such hypodermal pentactins as have paratropal paratangentials.

In certain very small specimens I ascertained that the hypodermalia consisted of pentactins alone. Some of these showed paratangentials with microtubercles sparsely distributed throughout the length, and seemed to intergrade with the larger dermalia.

Whereas, in all the larger specimens the paratangentials of hypodermal pentactins are usually accompanied by a greater or less number of slender diactins, which are scarcely distinguishable from parenchymalia of similar dimensions. In some places

the strands consist of the diactins only, and in still other places these are seen to run singly, not being combined into bundles.

The *hypogastral* strands are made up of similar diactins, and of diactins only.

The *dermalia* (Pl. XV., figs. 4-6) are almost exclusively stauractins; rarely pentactins and still more rarely tauactins or diactins. The stauractins are very slightly convex on the outside. On some of them the atrophied proximal ray, and occasionally also the distal, may be represented by a boss-like protuberance. Length of rays, 100-165  $\mu$ ; breadth at base, 6-9½  $\mu$ . The rays may be said to be entirely rough; and it is a remarkable fact that the microtubercles on their outer surface are developed into more or less prominent, conical and vertically erect spines. Those on the lateral sides of the rays are much less strongly developed, while those on the inner side may be said to be obsolete. The length attained by the spines on the outer surface differs somewhat in different individuals, but at all events their unusually strong development constitutes one of the characteristics of the species. Even in a small specimen of only 6 mm. height, the spines in the position indicated are quite prominent, though much thinner than in the larger specimens.

The *gastralia* (Pl. XV., fig. 7) are oxyhexactins of a moderately large size. All the six rays in one spicule may sometimes be of nearly equal length, but more frequently the free proximal ray is the longest and the distal the shortest. Length of proximal rays, 450-560  $\mu$ ; of paratangential rays, 330-352  $\mu$ ; and of distal rays, 190-262  $\mu$ . Thickness at base, about 10  $\mu$  on an average. The tapering rays belonging to one and the same spicule may

all be nearly equally rough on account of the presence of microtubercles, but the usual condition is that the prolonged proximal ray is, in comparison with the others, much more pronouncedly rough, the microtubercles on it being developed into distinct, conical and vertically projecting prickles.

The gastral hexactins are generally so arranged as to form with their paratangentials a continuous quadrate-meshed lacework, in which the sides of the meshes, exactly like those in the dermal lacework, are formed of the two apposed rays belonging to each of every two adjacent gastralial. Occasionally two gastralial lie very close together, making the four laths proceeding from their position three rays strong instead of two.

In the smallest specimen I have had (6 mm. high), the gastralial were quite sparsely present in scattered arrangement.

No special *canalaria* were found in the species.

The *oxyhexasters* (Pl. XV., fig. 10) measure 93–114  $\mu$  in diameter. They all seem to be normally developed, neither hemihexactinose nor hexactinose forms having been noticed. Further a distinction between those in the periphery of the wall and others more deeply situated can scarcely be drawn. The principals are usually short but distinct; sometimes they are quite obsolete. Two to four—commonly three—terminals are borne by a principal. They are generally thin and nearly straight, showing a slight roughness at base when seen under a high power of the microscope. In some of the rosettes the terminals may be nearly twice as thick as in others with which they promiscuously intermingle.

The above oxyhexasters are not found in the ectosome, but occur abundantly in the choanosome, especially in the deeper



parts. Very frequently they are seen shifted out to a point midway towards, or right on the tip of, the free proximal rays of gastral hexactins (fig. 11).

The *discoctasters* (Pl. XV., fig. 9) are common in the deeper parts of the wall, probably never occurring in the subdermal space. They may attain a size larger than is known to me from any other Acanthascinae. Diameter, generally 500-660  $\mu$ , but sometimes reaching down to 300  $\mu$  or even less. In the very young specimen of only 6 mm. height, the discotasters, of which only two or three in all were found, measured 240-352  $\mu$ .

The central node is of a plain appearance. The secondary principal gently thickens outwards, forms about one-third of the entire ray-length and splits at the outer end into five or six slightly rough, but sometimes nearly smooth, straight and slightly divergent terminals, which together give rise to a tuft of an elongate conical shape. The terminal disc is without marginal teeth, being simply like a pinhead in shape.

*Microdiscohexasters* (Pl. XV., fig. 8) of spherical shape and 15-22  $\mu$  diameter occur extremely rarely in the older specimens, but are not uncommon in the younger. They are found on or near to both the dermal and gastral surfaces. About ten terminals of extreme fineness, each having a minute terminal swelling, occur to the flat or externally convex disc at the outer end of each moderately long principal.

Finally—the basidictyonal plate (Pl. XV., fig. 12) is of quite a similar appearance as in other species of the subfamily. In the larger specimens it is of a considerable thickness and consists of both directly and synapticularly connected, thick-rayed and mi-

erotuberculate hexactins, amongst which there occasionally occur pentactinic and even stauractinic forms. Its surface in direct contact with the substratum is lined with a thin and particularly close-meshed reticular layer, the limiting basal-plate.—Of the small basidietyonal mass shown in fig. 13, I have already spoken on p. 210.

### STAUROCALYPTUS HETERACTINUS IJ.

Pl. XI., figs. 1–10.

*Staurocalyptus heteractinus*. IJIMA, '97, p. 56.

This species was described by me in '97 from a single specimen. A second specimen has not been obtained.

The type-specimen (Pl. XI., fig. 1 ; S. C. M. No. 409) comes from a depth between 501 and 572 m. It is of the size of a bean and represents a strongly laterally compressed pouch, measuring 21 mm. long and 10½ mm. broad in one direction and 6 mm. broad in another. On one side of the upper rounded end is the small oval-shaped osculum with its thin simple edge. The opposite end shows two processes with torn off terminations. Both these processes probably served to fix the sponge to the substratum. Thickness of wall at the middle of the body, about 2½ mm. Possibly the specimen is a young individual.

The external surface is tolerably smooth, being without protals of any kind. Examined under the hand-lens, there are seen to proceed upwards from the basal processes obliquely running and intersecting strands of rather coarse fibers which build up

the parenchyma. Close over this is an ill-defined hypodermal network with irregular meshes of various sizes. The dermal layer is only partially preserved, and is very indistinct. The incurrent canalar apertures are represented by small gaps between the parenchymal strands and quite occasionally by pit-like but shallow depressions.

The gastral surface exhibits a number of freely open excurrent apertures, which may reach up to  $\frac{3}{4}$  mm. in diameter. Some of the excurrent canals are pit-like but never deep in relation to the thinness of the sponge-wall.

Altogether, the appearance of the wall is much like that of the oscular region of a larger Acanthascine species.

### Spiculation.

The *parenchymalia* include an abundance of comparatively strong principalia of elongate spindle-shaped or bow-shaped oxydiactins, which may attain a length of 12 mm. and a breadth of 220  $\mu$  at the middle. In them the ends are smooth. The smaller parenchymalia present no features worthy of special mention.

The *hypodermalia* (Pl. XI., fig. 2) are moderately large and strong pentactins, occurring commonly but in irregular distribution. The paratangentials, which are regularly cruciate and never paratropal, usually measure under  $\frac{1}{2}$  mm. in length but are sometimes longer. The unpaired proximal ray is always much longer than the paratangentials. The rays may be 30  $\mu$  thick at base. The surface near the conically pointed tip is either quite smooth or sparsely beset with microtubercles. Occasionally the hypoder-

malia are represented by paratangentially situated stauractins; more rarely by tauactins. Certain diactins seem also to lend themselves to the formation of hypodermal strands.

The *dermalia* (Pl. XI., figs. 3 and 4) are predominantly stauractins, occasionally pentactins and tauactins and rarely diactins. The rays are slightly rough all over and have rounded tips, which are occasionally somewhat swollen. The size varies considerably, some of the spicules being in axial length twice or even three times as long as the smallest. Thus, a small dermalia measured had rays of only 90  $\mu$  length and 9  $\mu$  thickness at base, while a large one may have rays 270  $\mu$  long and 13  $\mu$  thick. The largest nearly approaches the size of the smallest hypodermalia, but the latter seem to be always distinguished from the former by the fact that the rays are rough at the ends only. Exceptionally thin-rayed and smooth oxystauractins, found here and there in the dermal layer, I take to be dermalia that are still in an incomplete state of development. The separate dermalia are irregularly disposed as regards the mutual orientation of their paratangentials.

The *gastralia* (Pl. XI., fig. 5) are pentactins and stauractins, the former being present in somewhat greater relative abundance. Rarely are they tauactins or diactins. The rays are quite like those of the dermalia but are generally smaller. Length of rays, 55–100  $\mu$ . Average thickness at base, 6½  $\mu$ . In the pentactins the unpaired ray is directed distad; sometimes the proximal ray is represented by a boss. The gastralia are nowhere numerous present.

The *oxyhexasters* (Pl. XI., figs. 7 and 8) have a diameter of 106–114  $\mu$ . They seem to be never hemihexactinose or hexactinose. As regards appearance they may be divided into two categories, which seem however to intergrade. The one category (fig. 7) is composed of those mostly lying in the periphery of the sponge-wall, and in them each principal of a perceptible length bears 2–4 (usually 3), slender and obsoletely rough or nearly smooth terminals. To the other category (fig. 8) belong the great majority of the oxyhexasters abundantly present near the gastral surface and occasionally a few of those found in the periphery. In these the principals are extremely short and bear each 2 (sometimes 3), strong and distinctly rough terminals. The roughness may be developed into retroverted microspines or barbs on the basal parts of the terminals.

The *discoctasters* (Pl. XI., fig. 6) vary in diameter from 110  $\mu$  to 200  $\mu$ . They are tolerably common, especially near the gastral surface. Those in the periphery of the wall are on the whole smaller than others more deeply situated. In the former (of which Pl. XI., fig. 15, in reality taken from an undetermined *Staurocalyptus*, might well pass for a representative) the secondary principals are as slender as 4  $\mu$  or less. In the latter (fig. 6) the same may be fully 6  $\mu$  thick. Generally speaking, the central node is either plain or is supplied with the six boss-like prominences. The secondary principals make up about two-fifths of the entire ray-length. The terminals, 2–7 in number to a principal, are straight and form a tuft which expands generally but little outwards. The terminal discs appear simply like pinheads.

The microdiscohexasters (Pl. XI., fig. 9) are of the usual

appearance. Diameter, 16–19  $\mu$ . They occur in scattered distribution both near the gastral surface and in the peripheral parts. In some places in the dermal membrane I find them to be quite common.

### STAUROCALYPTUS PLEORHAPHIDES IJ.

#### Pl. XVI.

*Staurocalyptus pleorhaphides*. IJIMA, '97, p. 58.

Three specimens of this species have come under my observation. Roughly speaking, they all represent thick-walled, elongate, pear-shaped sacs, firmly attached by the narrowed lower end and provided with prominent prostal needles and pentactins. In external appearance the species bears a close similarity to *Scyphidium longispina*.

The first specimen (Pl. XVI., fig. 2; S. C. M. No. 226) is from a depth of between 429 and 572 m. in Homba. Height of body, 43 mm. Greatest breadth, 23 mm. Greatest thickness of wall, 6 mm. The roundish osculum at the upper end, 7 mm. in diameter; leading into a deep cylindrical gastral cavity. Base, stalk-like; 6 mm. thick.

The second specimen (Pl. XVI. fig. 2; S. C. M. No. 415) comes from a depth of about 300 fms. (say, 550 m.) in Inside Okinosé by the Sengenzuka-line. It is attached on the external side of a *Hexactinella loricata*. Body, 55 mm. long; somewhat laterally compressed, measuring 35 mm. by 26 mm. in breadth at the middle. Basal end, 10–12 mm. broad. The irregularly el-



liptical osculum on one side of the upper end, 13 mm. by 7 mm. across. Thickness of wall in the middle, 8 mm.

The third specimen again is attached to a large *Hexactinella loricata* (S. C. M. No. 448), together with *Lanuginella pupa*, *Leucopsacus scoliocus*, etc. Locality, Outside Okinosé by the Iwado-line. Total height, 40 mm. Greatest breadth, 30 mm., the body being nearly circular in cross-section. Thickness of wall in the lower part, about 10 mm. The roundish osculum, 13 mm. in diameter.

The following are the details of the macroscopic characters of all the three specimens taken together.

The oscular margin is thin and simple-edged. By far the greater part of the external surface is uneven on account of the presence of numerous small conuli, lying at distances of 3-10 mm. from one another. From each such conulus there spring a number of prostal spicules arranged in a loose divergent bunch. The prostal bunch generally comprises both diactins and pentactins, but sometimes consists of the latter alone.

The diactinic prostals are generally strong needles of various lengths. They may project to a length of 25 mm. or more, being directed on the whole obliquely outwards and upwards, though there may exist some that proceed straight outwards or even somewhat downwards. Those in the broadest part of the body are the longest. The needles give an altogether spiny appearance to the sponge. Seen under the hand-lens, some of them may present a dirty brownish color due to a thin incrustation of some foreign substance. Adhering to them are seen here and there some animal remains, among which Foraminifera shells are the more common.

The pentactinic prostals are of a moderately large size. They

form over the dermal surface a gossamer-like covering, which in places is about 5 mm. thick. They generally protrude in groups of two or more but may sometimes stand out singly.

The dermalia, together with the hypodermal spicular rays, form quite an irregularly meshed latticework. The meshes are never quadrate but triangular, trapezoidal or indefinite in shape. This irregularity has its explanation in the fact that the dermalia are predominantly straight diactins, which may lie in all possible directions in the plane of the dermal layer (Pl. XVI., fig. 15).

The subdermal space is inconspicuously developed. The variously sized apertures of incurrent canals are largest in the broadest region of the body. Here they occasionally measure 3 or 4 mm. across. Apertures of a similar size are separated from one another by a space as wide as, or wider than, their own width.

The gastral surface presents a loosely felt-like appearance, not being covered with a well differentiated endosomal layer (Pl. XVI., fig. 1). On it the excurrent canals, up to 5 mm. in width, open with free apertures. These canals are mostly not deep but are seen soon to divide up into branches.

### Spiculation.

The larger *parenchymalia*, which may be called the principalia, are elongate spindle-shaped oxydiactins, either nearly straight or gently bent in a bow-like manner. They may attain dimensions of 7 mm. length and 80  $\mu$  breadth at the middle. The ends are usually rough in varying degrees; in other cases they are smooth. Under certain circumstances, one end of the diactins

may be rounded while the other is as usual acutely pointed, as e.g. in some of those diactins that just reach the dermal surface with one of their tips, in which case it is the distal end which may be rounded off (Pl. XVI., fig. 14).

The smaller parenchymalia, including the fine comitalia, are of the usual appearance. They seem to grade down in dimensions uninterruptedly to the small diactins which I shall describe further on as the gastralialia.

The *proctal diactins*, which are in fact to be regarded as enormously developed parenchymal principalia, are of various sizes. A small one may measure only 10 mm. in length, while the largest measured was 40 mm. long and 253 $\mu$  thick. The needle-like spicules are straight or nearly straight, tapering perceptibly towards both ends. The outer end is usually found to have been broken off; the inner is either acutely or bluntly pointed, the subterminal surface being smooth or sparsely beset with microtubercles. The entire exposed surface of the proctal needles,—at least, of the larger of these,—is minutely and densely rough, in exactly the same way as the paratangentials of certain proctal pentactins soon to be described. The roughness extends a short distance into the parts rooted in the sponge-wall, gradually fading into a perfectly smooth surface. The parts in the wall, as also the same parts of the shafts of hypodermal and proctal pentactins, are generally accompanied by some comital parenchymalia.

The *hypodermal pentactins* are somewhat variable in size. The paratangentials, which are generally not quite straight but rather wavy, may be 5 mm. long or longer. The straight shaft or the unpaired proximal ray is always much longer than the

paratangential in the same spicule. The pentactins situated near the oscular margin and already externally protruded as prostalia, I have found to be unusually small, measuring not more than half a millimeter in the length of paratangentials, which in these small pentactins are generally arranged in the form of a regular cross to each.

This cruciate arrangement of the paratangentials also occurs, but only occasionally, in the larger pentactins lower down on the sponge. In by far the greater number of these the rays referred to are paratropal. The paratropism is carried out to varying degrees in different spicules. In some cases, one of the four angles formed by the rays is simply obtuse while the rest are all acute though greater than  $30^\circ$  each; in other cases the four rays form only three angles, each of about  $30^\circ$  or less. It is to be noted that whenever two or more paratropal pentactins form a close group, whether by themselves alone or in company with diactinic prostalia, the paratangentials of each pentactin are, as it were, pushed away from the center of that group (Pl. XVI., fig. 14). I shall have to return to this point under *Rhabdocalypthus victor*.

All the rays of the pentactins are at first smooth except at the ends which are rough. So are they in most of the spicules in the hypodermal situation; however, here and there among these are to be seen such as show the paratangential cross finely rough all over. The roughness is caused by minute, erect and sharply pointed processes, which, when seen from above, appear to be somewhat laterally compressed so as to present a shape elongated in the direction of the axis of the ray they beset (Pl. XVI., fig. 13). The microspines reminds me of those I have seen on the prostal pentactins of *Scyphidium longispina*. To judge from what appear to represent developmental stages, the

roughness first sets in as an extension of that at the ends of the paratangentials; thence it proceeds to develop towards the spicular center and from this point proximad for a short distance on the shaft. Not that the roughness develops on all the old pentactins before these are protruded as prostalia. Of those which already stand out and form the gossamer-like covering on the exterior, many indeed have the rays roughened in the manner described; but in certain others these are perfectly smooth except subterminally. It is difficult to say if all the latter will eventually acquire the character of the former.

Running along with hypodermally situated paratangentials are occasionally seen some fine diactins, which thus help to support the dermal layer.

The *dermalia* (Pl. XVI., figs. 3-5) are rough diactins. Exceptionally they may be stauractins or tauactins; extremely rarely, orthodiactins and monactins.

The diactins measure 264-520  $\mu$  (on an average, 400  $\mu$ ) in total length and about  $9\frac{1}{2}$   $\mu$  in thickness at the middle. They are generally gently bent in a bow-like manner, the concavity facing downwards. They taper slightly towards both ends which are either rounded or conically but bluntly pointed. The center is usually without an external swelling; only occasionally it is marked by a pair of opposite bosses and much less frequently by a single unilateral boss.

A noteworthy feature of the present species consists in the fact that the *gastralia* are represented by straight diactins. I at first felt inclined to pass over the matter by simply assuming a total absence of gastralia for the species. Upon further studies, how-



ever, and having found the same diactins in like abundance over the entire gastral surface of the three specimens examined, I have come to see no inappropriateness in calling them the gastralialia. Moreover, a second Acanthascine species with diactinic gastralialia is now known, viz., *Rhabdocalyptus plumodigitatus* R. KIRKP. It should, however, be said that the gastralialia in the present species seem to intergrade with the parenchymalia by an uninterrupted series of transitional forms. Like the dermalia, the gastralialia lie in quite irregular disposition on the gastral surface (Pl. XVI, fig. 16).

Many of the gastralialia are much like the dermalia both in dimensions and general appearance. What may perhaps be mentioned as slight deviations shown by the former are the facts that the microtubercles on the surface are on the whole more sparse and more thinly scattered and that the middle of the spicules is frequently, but not always, marked by a gentle annular swelling. Many others of the gastral diactins are considerably larger (Pl. XVI, fig. 6), acquiring characters approaching those of parenchymal diactins. With the increase in size, the microtuberculation becomes more and more sparse except at the ends, finally rendering the middle parts of the spicules perfectly smooth.

In one specimen (No. 226), in which I have studied the spiculation most closely, I find the gastral skeleton in the proximity of the osculum scarcely at all distinguishable as to its elements from the dermal. That is to say, the gastralialia in that region contain, besides an abundance of the rough diactins, occasional stauractinic and tauactinic forms, underlying which spicules are some hypogastral pentactins with cruciate paratangentials. Deeper down and in by far the greater part of the gastral surface, the hypogastral pentactins are not found, while



as gastralria there occur only diactins though in somewhat diminished numbers.

The *oxyhexasters* (Pl. XVI., fig. 7), occurring in moderate abundance in all parts, are partly normally developed and partly hemihexactinose. Hexactinose forms, with the terminals either straight throughout or bent at base, were met with in only a few cases. Diameter,  $114\mu$  on an average. The terminals are rather strong, measuring about  $2\mu$  across at base; they are nearly straight or slightly bent and show a rough surface, due to microtubercles which are sometimes distinctly retroverted but never much prolonged. The principals are extremely short and often almost obsolete.

In most normal oxyhexasters all the principals bear two terminals each, so that the total number of terminal points is twelve. Sometimes some—not all—of the six principals may show three terminals, in which cases the points in one spicule number more than twelve in all. Thus, not rarely have I come across normal oxyhexasters with sixteen or seventeen terminal points. In the hemihexactinose forms, the uniterminal rays are either straight or bent at base, the rest of the rays being always biterminal.

The peculiarly twisted and evidently malformed oxyhexaster, shown in Pl. XVI., fig. 8, was observed but once. It possesses six terminals in all, but these evidently belonged not to as many principals, but to the four or five remaining of the original six principals. The curvature of the rays is in different planes, the relative orientation of which could not be determined.

The *discoctasters* (Pl. XVI., figs. 9–11) are present in abun-

dance in the entire wall. They are slender-rayed and on the whole small though of various sizes. The diameter is usually  $140-200\ \mu$ ; occasionally, only  $100\ \mu$ . The central node is either plain or tubercled. The principals are about half as long as the terminals. Number of terminals to a principal, 2-4; usually 3; probably never more than 4. They form a slightly diverging tuft and are nearly straight or perceptibly bent outwards. Under a high power of the microscope they appear to be rough-surfaced. On the minute terminal discs the marginal serration is unrecognizable.

Malformed discoctasters, in which one or more primary terminals stand free without fusing with any of the secondary principals, are of no infrequent occurrence.

The *microdiscohexaster* (Pl. XVI., fig. 12) are of the usual appearance and  $20\ \mu$  in diameter, and are found, mostly near the gastral surface, in small numbers and in scattered distribution.

Finally, as to the basal plate. I have seen this in the specimen shown in Pl. XVI., fig. 2, which is attached to a *Hexactinella lorica*. The dictyonal skeletal parts of this sponge, at the place where the said specimen is fixed, are enveloped in a thin, small-meshed, siliceous reticulum, evidently the limiting basal-plate of the latter. The beams of this plate are sparsely microtuberculate and look quite like those I have figured in Pl. XXII., fig. 17, from *Rhabdocalyptus capillatus*. Outside that plate and in the sponge under consideration there may possibly occur at places some basidictyonal hexactins, but these were not actually encountered.

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## UNDETERMINED STAUROCALYPTUS.

Here I wish to mention three specimens ( $\alpha$ - $\gamma$ ) which I have studied but prefer to leave unnamed, though placing them provisionally under *Staurocalyptus*. They are all very small and therefore very probably young specimens in which the characters may not have been fully developed.

*Staurocalyptus* SP.  $\alpha$ .

(Figures already published in Contrib., III., Pl. III., figs. 1-6).

This little specimen (S. C. M. No. 437) was found on a dead *Hexactinella lorica* from Outside Okinosé, together with *Leucopsacus scoliodocus*, *Lanuginella pupa*, etc. The body of a barrel-like shape is somewhat larger than a grain of rice. It shows at the lower end a rigid basidictyonal mass measuring about 2 mm. across. From that mass, as also from the body proper, there spring out some fine prostal needles of a considerable length, mostly directed obliquely upwards and outwards. The dermal surface is smooth.

The parenchymalia are chiefly diaetins under  $14\mu$  in thickness. In most of them the spicular center is marked externally by an annular swelling or by two or four knobs arranged in the usual manner. It seemed to me that the subterminal roughness extended over a relatively greater area than usual, some of the shorter diaetins showing sparsely distributed obsolete microtubercles nearly all over them. Highly remarkable is the fact that some of the parenchymalia are apparently hexactinic. The parenchymal

oxyhexactins may have rays  $95\mu$  long and  $8\mu$  thick at base, the entire surface being thinly microtubercled. Their position and manner of occurrence scarcely warranted interpreting them as gastralialia.

The dermalia are both stauractins and pentactins in about equal numbers (Contrib. III., Pl. III., fig. 1). Size various,  $43$ – $152\mu$  in length of rays and  $4$ – $9\mu$  in breadth at their base. The relatively strong and slightly tapering rays are entirely rough on account of sparse but distinct microtubercles. The atrophied rays are sometimes represented by an external and an internal knob in the stauractins, and by an external knob in the pentactins. The larger dermal pentactins approach in size the pentactinic hypodermalia in which the paratangential rays may reach  $380\mu$  in length and are smooth except near the ends.

The gastralialia are hexactins found in scattered distribution (*l. c.*, Pl. III., fig. 2). Rays as in dermalia; length,  $34$ – $72\mu$ .

Oxyhexasters (*l. c.*, Pl. III., figs. 3 and 4) are of common occurrence. They are normally developed, there being two or three, slender and rough-surfaced terminals to each principal, which is short. Diameter,  $88$ – $106\mu$ .

Discoctasters (*l. c.*, Pl. III., fig. 6), a small number found; small and slender-rayed; measuring  $130$ – $144\mu$  in diameter.

Microdiscohexasters (*l. c.*, Pl. III., fig. 5), very small and delicate;  $15\mu$  in diameter. They occur in abundance in the wall, but especially in the periphery.

The basidictyonal mass is of the usual structure, being composed of fused hexactins with thick, short and sparsely microtubercled rays. The skeletal beams of the *Hexactinella*, at the spot giving attachment to the specimen, are entirely enveloped by a thin and small-meshed limiting plate.

The spiculation as described above seems to come nearest to, and indeed closely resembles, that of *Staurocalyptus ræperi* (F. E. SCH.). But, under the circumstances, I hesitate to make a definite specific determination.

*Staurocalyptus* sp.  $\beta$ .

(Figures in Contrib. III., Pl. III., figs. 7-13).

On another *Hexactinella loricæ* from an unknown spot in the Sagami Sea was found the small specimen here to be described, together with some other Hexactinellid species (*Leucopsacus scoliodocus*, *Lanuginella pupa*, *Staurocalyptus pleorhaphides*).

The specimen is shown in *l. c.*, Pl. III., fig. 9. Barrel-shaped; only about  $4\frac{1}{2}$  mm. high; with numerous fine prostal needles and a deep gastral cavity. A comparatively wide subdermal cavity exists.

The parenchymalia are all slender diactins, rough only near the sharply pointed ends and generally without a swelling around the spicular center. Prostal needles, 4 mm. or over in length and up to  $57\ \mu$  in thickness.

The dermalia are mainly oxystauractins and rarely oxypentactins, in both of which the cruciate paratangentials are slightly convex on the distal side. Rays, slightly rough;  $100-154\ \mu$  long and  $6-7\frac{1}{2}\ \mu$  thick at base. (For the dermalia and hypodermalia, see *l. c.*, Pl. III., fig. 7).

The hypodermalia are oxypentactins with paratangentials up to  $450\ \mu$  long and  $27\ \mu$  thick at base. The rays are usually smooth except at the roughened ends, but in some of the spicules I have found the paratangentials thickly beset all over with

pointed microtubercles in much the same manner as in *Staurocalyptus pleorhaphides*.

Special gastralialia have not been found.

Oxyhexasters (*l. c.*, Pl. III., figs. 12 and 13), very abundant, generally normal and rarely hemihexactinose. Diameter, 68–114  $\mu$ . Terminals, two (at most three) to a principal; nearly straight; obsoletely rough; much thinner in the smaller than in the larger oxyhexaster.

Discoctasters or rather their representatives were found in quite a limited number,—only two cases in all which were discovered after a careful search throughout the entire specimen. They are both shown in *l. c.*, Pl. III., figs. 10 and 11. The case of fig. 10 is without doubt that of a malformed discoctaster,—at any rate, one in which some of the primary terminals remain free without uniting into secondary principals, though certain others are united into such for a short distance and situated in proper positions on the central node. This central node is nearly cubical and shows the rounded bosses corresponding to the primary principals. Diameter, 122  $\mu$ . The other case, shown in *l. c.*, fig. 11, may almost be called a discohexaster, in which the primary principals are in part still distinct and partly fused together. The terminals are all free and radiate in all directions from the irregularly shaped central mass, showing as yet no trace of rearrangement into the eight bunches of a discoctaster. I regard the spicule, though possibly a case of deformity in itself, as representing an early stage in the transformation of a discohexaster into a discoctaster. Speaking on *a priori* grounds, discoctasters should have passed through a phylogenetic stage appearing much like the spicule now in question. Diameter, 85  $\mu$ .

Microdiscohexasters, quite like those of *S. sp. a* (*l. c.*, fig. 5).



They are common on or near the gastral surface. The terminals are so fine that it is difficult to observe them in Canada-balsam preparations.

Basidictyonal beams as in *S.* sp.  $\alpha$ ; nearly smooth, the scanty microtubercles present being quite obsolete.

*Staurocalyptus* sp.  $\gamma$ .

(This Contrib., Pl. XI., figs. 11-15).

On the same *Hexactinella loricata* as that which bore the foregoing specimen ( $\beta$ ), was found another (Pl. XI., fig. 11) of about the same size and appearance but differing somewhat in some points of the spiculation.

Parenchymalia, as in *S.* sp.  $\beta$ . Prostal oxydiactins, under  $34\ \mu$  in thickness.

Dermalia (fig. 13), exclusively stauractins; more or less convex on the outside and with slightly roughened rays  $90-230\ \mu$  long and not thicker than  $7\frac{1}{2}\ \mu$  at base.

Hypodermal oxypentactins, moderately large; with comparatively slender rays, which are smooth except at the roughened end. Length of paratangentials, up to  $700\ \mu$ ; thickness at base, under  $11\frac{1}{2}\ \mu$ . The unpaired proximal ray is longer than,—frequently fully twice as long as—the paratangential in the same spicule.

No gastralial, nor microdiscolaxasters, were discovered.

Oxyhexasters in moderate abundance (fig. 14); normal and all of a uniform appearance. Two or three, sometimes four, slender, rough terminals to a principal which is very short. Diameter,  $128-138\ \mu$ .

Discoctasters (fig. 15), common. The six bosses present on the central node. Principals slender, at most  $4\mu$  thick; about  $\frac{1}{3}$  the length of the entire ray. Terminals fine, 3–6 in a gently expanding tuft, with the minute terminal disc shaped like a pinhead. Diameter of the spicule, 128–160  $\mu$ .

Basidiectyonalia, as in *S. sp. 1*?

In spiculation the specimen seems to resemble most closely a young *S. glaber*, but differs not inconsiderably in the qualification of the roughness of dermalia and in the size of oxyhexasters as well as of discoctasters,—differences which at least render doubtful the propriety of considering the specimen as of that species. I have come to this view after carefully comparing it with the smallest specimen (6 mm. high) of *S. glaber* in my possession.

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### RHABDOCALYPTUS F. E. SCH.

Hypodermalia include pentactins in which the paratangentials, when fully developed, bear series of strong hook-like or prong-like spines. Veiled, but in some cases the veil may be lost.

#### Key to the known species.

- a.*—Dermalia predominantly pentactins, or pentactins and stauractins in nearly equal numbers.
- a*<sup>1</sup>.—Discoctaster not more than 100  $\mu$  in diameter.
- a*<sup>2</sup>.—Discoctaster with nearly straight terminals, which diverge but slightly outwards in each tuft. Dermalia pentactins, occasionally stauractins.....
- .....*R. dawsoni* (LAMBE). (Pacific coast of N. America).

- b*<sup>2</sup>.—Discoctaster with terminals bent outwards in each tuft. Dermalia pentactins, occasionally hexactins. (Oxyhexaster with spherical central node).....*R. tener* F. E. SCH. (C. of California).
- b*<sup>1</sup>.—Discoctaster more than 150  $\mu$  in diameter.
- c*<sup>2</sup>.—Oxyhexasters normal, hemihexactinose and hexactinose.
- a*<sup>3</sup>.—Discoctaster, 150–200  $\mu$  in dia. Dermalia pentactins, less frequently stauractins. Gastralial, hexactins and pentactins.....*R. asper* F. E. SCH. (C. of California).
- b*<sup>3</sup>.—Discoctaster, 240–300  $\mu$  in dia. Dermalia, stauractins and pentactins. Gastralial oxyhexactins. (Oxyhexaster with spherical central node).....*R. nodulosus* F. E. SCH. (C. of California).
- d*<sup>2</sup>.—Oxyhexasters, all hexactinose. Discoctaster about 200  $\mu$  in diameter. Dermalia pentactins, stauractins and diactins. Gastralial hexactins with the proximal ray 600–800  $\mu$  or more in length.....*R. tenuis* (F. E. SCH). (C. of California).
- b*.—Dermalia nearly all stauractins. (Discoctaster, 180–240  $\mu$  in dia. Oxyhexaster, 180–280  $\mu$  in dia.).....*R. victor* IJ. (Sagami Sea).
- c*.—Dermalia nearly all or at least predominantly compass-needle-like diactins.
- c*<sup>1</sup>.—Sponge firmly attached at base to solid substratum. Gastralial hexactins.
- c*<sup>2</sup>.—Discoctaster more than 130  $\mu$  in dia.; reaching up to about 180  $\mu$ .
- c*<sup>4</sup>.—The radial axis of gastralial about as long as, or shorter than, the length of the longest dermalia. The free proximal ray of gastralial about as long as any other ray in the same spicule.
- a*<sup>4</sup>.—Among the diactinic dermalia, stauractins and pentactins occur but rarely. Oxyhexaster terminals more or less distinctly barbed at base. ....*R. mollis* F. E. SCH. (Sagami Sea).
- b*<sup>4</sup>.—Among the dermalia, diactins are most numerous, but stauractins and pentactins are also abundant. Oxyhexaster terminals slightly roughened, not barbed. (Paratangentials of hypodermalia chagreened besides being spined).....*R. australis* TORS. (Antarctic).
- d*<sup>3</sup>.—The radial axis of gastralial nearly twice as long as the longest dermalia, or even longer. The free proximal ray is considerably prolonged over any other in the same spicule. (Among the dermalia, other forms than diactins occur, but quite exceptionally. Oxyhexaster terminals smooth or obsoletely rough).
- c*<sup>4</sup>.—Oxyhexaster only occasionally hexactinose. Discoctaster with principals 20–25  $\mu$  in length; terminal discs toothed on the external side only or with the teeth much more strongly developed on that side than on the inner. Microdiscohexaster, 22–30  $\mu$  dia.....*R. unguiculatus* n. sp. (Sagami Sea).
- d*<sup>4</sup>.—Oxyhexaster, mostly hexactinose. Discoctaster with principals only about 8  $\mu$  in length; terminal disc equally toothed all around. Microdiscohexaster, 32–40  $\mu$  in dia.....*R. mirabilis* F. E. SCH. (S. of Alaska).
- f*<sup>2</sup>.—Discoctaster small; 82–106  $\mu$  in dia.; terminal tuft distinctly flaring at the outer end.....*R. capillatus* IJ. (Sagami Sea).
- d*<sup>1</sup>.—Sponge with finger-like basal processes and rooted in loose bottom by means of anchor-needles. (Gastralial, compass-needle-like diactins like the dermalia. Discoctaster of two kinds, large (130–160  $\mu$  dia.) and small (60  $\mu$  dia.).....*R. plumodigitatus* KIRKP. (S. Africa).

The four species occurring in the Sagami Sea, viz., *R. victor*, *R. mollis*, *R. unguiculatus* and *R. capillatus*, will now be dealt with in detail.

### RHABDOCALYPTUS VICTOR IJ.

Pls. XVII., XVIII., and XIX.

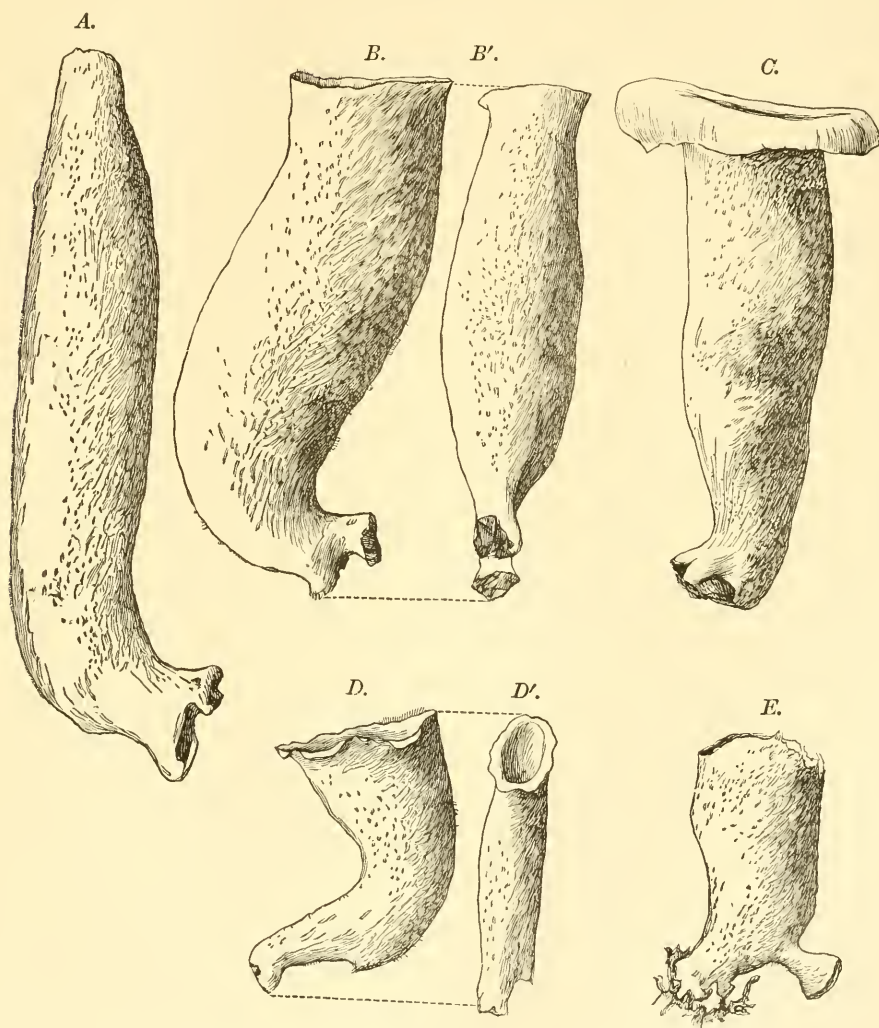
*Rhabdocalyptus victor*. IJIMA, '97, p. 52.—CH. GRAVIER, '99, p. 421.

Specimens of this species have passed through my hands in no small numbers. The localities in the Sagami Sea where they have been obtained, so far as is known to me, are: Homba (572–859 m.) and Outside Okinosé (by both the Iwado and Sengen-zuka lines, 501–572 m.). In these localities the species seems to be moderately common. Most of the specimens bore at the base samples of a tufaceous bottom; others grew on corals, on dead *Chonclasma* or on *Hexactinella lorica*.

On the following page (text-fig. 8) and in Plate XVII., I have depicted several of the better preserved specimens that I have seen, which are illustrative of the shapes assumed by the species.

In text-figure 8, in which all the figures are drawn to the scale of  $\frac{1}{8}$  natural size, A represents a specimen which belonged to Mr. OWSTON. It was 23 inches high. Ocular margin directed upwards. Lateral compression of body especially distinct at the base, which is bent in the sagittal plane.

*B* and *B'*, two views of a similarly shaped but relatively broader specimen (S. C. No. 425); *B'*, as viewed from the side of the lesser curvature of the body. Height, 550 mm. Diameters



Text-figure 8.—*Rhabdocalypus victor*. All in  $\frac{1}{8}$  natural size.

of the oval-shaped osculum, 176 mm. and 118 mm. At the middle of the body, the likewise oval cross-section presents



diameters of 212 mm. and 148 mm. The strongly compressed base measures only 37 mm. in thickness from side to side. Thickness of wall at the middle of the body, 9.5 mm; farther below, up to 12 mm. Basal end attached to the substratum at two places, between which is a free dermal surface still preserving a number of pentactinic prostalia.

*C*, a specimen (S. C. No. 460) slightly bent at the base and with the oscular margin expanded outwards all around and bent backwards. Height, 570 mm. Body laterally compressed but only to a slight degree. Pentactinic prostalia preserved in many part of the dermal surface.

*D* and *D'*, two views of a specimen with bent body (S. C. No. 267). Height, 348 mm. The oval osculum, 170 mm. by 73 mm.; elongate in the sagittal direction; with flaring oscular rim. In the middle of the body the breadths are 100 mm. sagittally and 77 mm. transversely. The base is nearly round in cross-section, measuring about 46 mm. across. A low conical outbulging is seen at about the boundary between the lower and the middle third of the body on the side of the greater curvature but to one side of the median line. This is undoubtedly the beginning of the formation of a daughter person; but a secondary osculum has not yet opened itself at the summit. Thickness of wall at about the middle of the body, 10 mm.

*E*, a slightly bent specimen (S. C. No. 416) attached by tubercle-like basal processes to a branched coral. Below and on one side is a funnel-like daughter person. Height, 285 mm. Near the upper end the walls of the two sides have come into contact and have fused together. Above this place of fusion, the gastral space and the original main osculum are narrow and slit-like; below it is the main part of the gastral cavity which



communicates with the exterior only by means of the (secondary) osculum of the daughter person.

Essentially similar in shape is the magnificent specimen shown in Pl. XVII., reduced to one-fourth of the natural size (S. C. M. No. 423; from Homba, about 859 m.). The circumstances of its capture I have already had occasion to relate in my Contribution I., pp. 24-25. Its total height is 880 mm. As in many other cases, the body is laterally compressed, the compression being especially distinct in the stalk-like basal region which is bent towards one side. The major and minor diameters of the osculum are 400 mm. and 300 mm. respectively; those of the body at about its middle, 270 mm. and 220 mm. The basal region measures only 50 mm. transversely from side to side. The lower end of the body is continued, in the direction opposite to the main osculum at the upper end, into a laterally compressed outbulging, which soon divides into two thin-walled tubes, situated one behind the other in the median sagittal plane and each terminating in a secondary osculum directed downwards. The irregular attachment surface of the bent base is (superio-inferiorly) 180 mm. long and (transversely) 8.5 mm. broad. Judging from its disposition in relation to the directions of the oscula present, it is highly probable that the sponge was growing on a perpendicular surface. The wall is 14 mm. thick in the middle of the body; lower down, it is as thick as 19 mm. The gastral cavity extends into the laterally compressed base in the form of a vertical slit-like space, giving to the wall at the *cul-de-sac* end a thickness of only about 11 mm. On one side of the lateral wall (not seen in the figure) and at a short distance from the main osculum, there exists in the wall an irregularly shaped gap, apparently the result of a mechanical injury. The torn edge of

the gap had, so to say, healed and regenerated a natural looking edge which appears much like that of the osculum.

Speaking of the larger specimens in general, the shape is exquisitely vase-like and in a measure laterally compressed. The sponge stands either erect or is bent at the base. In the latter case the bending takes place invariably in the median plane containing the major diameter of the laterally compressed body. The daughter person or persons, occasionally found on the specimens, seem to be restricted in their location to the convex side of the bent basal region. The moderately thick wall is gradually thinned out at the oscular margin, which is sometimes outflaring and sometimes not. The base can not be said to be solid, since the gastral cavity extends almost to the attachment surface. The edge of the extreme base, as seen from the exterior, is often tubercled and indented reminding one of a cat's paw.

The thin oscular edge is of a finely granular or densely felt-like appearance. It may be perfectly simple but more usually is provided with a thin row of fine needle-like marginalia, not over 10 mm. in length. The intervals at which these stand out are usually irregular.

The dermal surface, when in a good state of preservation, is on the whole tolerably smooth except for the small papilla-like prominences and the slightly raised hypodermal strands, both soon to be referred to again. The dermalia form an exceedingly delicate lacework in which the minute meshes are quadrate in shape and measure on an average  $170\mu$  in length of sides. The hypodermal strands appear as thin streaks which, running in all directions, frequently intersect one another (Pl. XVIII., fig. 2). Upon closer attention it will be seen that they form a number of radial

patterns,—that they converge towards numerous central points, lying 3–7 mm. apart from one another. At each of these is situated the papilla-like prominence mentioned above. The radial pattern is caused by the paratangentials of a number of hypodermal pentactins which are arranged in a group (Pl. XVIII., fig. 16), their shafts and the accompanying comitalia combining together to form a loose, vertically dipping bundle. The axis of this bundle is occupied by the erstwhile comitalia to the shafts of proctal pentactins which were once present at the spot but are now lost. The outer ends of the comital spicules in question form a compact bundle and, projecting more or less beyond the dermal surface, give rise to the small papilla-like prominence at the center of each radial figure brought about by the hypodermal strands. In the inferior region of the body, the prominences are generally disintegrated and take the form of little parallel tuft of fine spicules, projecting to a length of 2 mm. or less (Pl. XIX., fig. 23); whereas, in the superior parts they are usually to be seen as whitish, slightly elevated spots. The proctal pentactins, when present, invariably stand out on the papilla-like prominences, either singly or a few together in a tuft.

However, proctal pentactins are in general but sparsely present in the mature specimens: they seem to become readily lost as they are somehow shed off. Many individuals are quite or nearly destitute of the proctalia in question, showing at most only a few isolated representatives of them. But under certain circumstances they may be somewhat extensively preserved not only in such parts as seem to be protected in a way from abrading influences but also on the exposed lateral surfaces. The spiny armature of the proctal paratangentials can be easily recognized when seen under the hand-lense. Diactinic proctalia, apart from those which

sometimes fringe the oscular margin, were not observed on the lateral wall of the larger specimens.

The subdermal space is narrow. The variously sized apertures of incurrent canals, visible through the ectosome, may be as large as 5 mm. in diameter (Pl. XVIII., fig. 2). The interapertural choanosomal surface, usually not wider than the width of the directly adjacent canalar apertures, shows an interweaving of fibers or strands which run irregularly but in the main in oblique directions. In the proximity of the basal attachment the parenchymal texture is dense and coarsely fibrous.

On the inner side of the wall, the endosome shows a continuous gastral lacework (Pl. XVIII., fig. 3) the quadrate meshes of which are distinctly visible to the naked eye. The gastral layer is supported below by a well differentiated system of hypogastral strands which are long and of various strengths under  $300\ \mu$  and which by intersecting one another enclose wide meshes of an irregularly angulate shape. Frequently the strands are seen to run over and across the apertures of the excurrent canals. Interaperturally the endosome is closely adherent to the choanosome.

The excurrent canalar apertures are of about the same size as the incurrent on the external side, but are somewhat more closely set together. Both the incurrent and excurrent canals are pit-like; when seen in sections of the body-wall, they are alternately arranged, their wall showing variously sized, oval or roundish entrances into the branches.

Finally, a few words with regard to the small and young specimens of the species. The smallest I have seen was only 23 mm. high, thin-walled and with an osculum of 3 mm. diameter

at the upper end. The next larger is the one depicted in Pl. XIX., fig. 17 ; height of body, 37 mm.; wall, 5 mm. thick in the middle ; osculum, 7-9 mm. in diameter. All the young of a similar or somewhat larger size are ovoid or barrel-shaped, and, besides being covered with a gossamer-like layer of prostal pent-actins, show numerous, fine, needle-like (diactinic) prostalia which spring singly from all parts of the external surface. Thus the young are, in general appearance, scarcely distinguishable from those of *R. capillatus* (Pl. XXII., figs. 3-5). It seems the diactinic prostalia lateralia are all lost during later stages of the growth, though in some individuals similar prostals may arise in later life but in such cases they are restricted in their distribution to the oscular rim (marginalia).

### Spiculation.

The *parenchymalia principalia* are bow-like oxydiactins with tapering rays which subterminally are either smooth or sparsely microtubercled. In large specimens they may attain 28 mm. in length and 400  $\mu$  in thickness at the middle ; such coarse spicules occurring especially abundantly near the external surface in the lower part of the body. The strength of the principalia of course varies with the size of specimens.

Close to the basal attachment I have found, abundantly in one large specimen but not in the same proportion in others, straight or bent parenchymal diactins, 8-15 mm. long and 20  $\mu$  thick on an average, in which the center is externally marked by an annular swelling while one or both of the ends are swollen, round-tipped and thickly beset with well-developed, conical micro-



tubercles. When one end only is thus swollen (Pl. XVIII., fig. 4), as is most frequently the case, the spicular center is situated very much nearer to that end than to the other; the spicule is quite unequally rayed, the ray which is directed towards, and almost or quite touches, the basidictyonal plate, being always the shorter and having the rounded tip. Even in this extreme basal region synapticular fusion never takes place between the parenchymal spicules, nor between these and the basidictyonalia.

The smaller parenchymalia, including the comitalia, are of the usual appearance and require no special description.

The *marginalia*, present on some specimens, are needle-like oxydiactins which may be 10 mm. or more in length and  $40\mu$  thick in the middle. The similarly shaped *prostalia lateralia*, seen only on small and young specimens, may be 20 mm. long and  $90\mu$  thick. Diactins further go to compose the long *hypogastral* strands. These are combinations of long comitalia-like diactins,  $7-35\mu$  (generally about  $10\mu$ ) thick and mostly without an annular swelling in the middle.

The *hypodermalia* are moderately large oxypentactins with paratropal paratangentials. They occur in close groups, generally of 4-8 each (Pl. XVIII., fig. 16), the manner of arrangement being typically that which I have described on p. 131. There are usually in each group one or two pentactins which have entirely smooth paratangentials; they are always the smallest and the most slender-rayed—*i. e.*, the youngest—of all in the group. The older pentactins being always situated at a higher level than the younger, the shafts of the former obstruct the paratangentials of the latter and prevent them from developing in a regularly cruciate



disposition ; hence, the paratropism. It may be said that in each group the oldest pentaactins are the most centrally situated ; thus, after their protrusion as prostalia lateralia ; they stand out from the center of a hypodermal group ; and when cast off, they leave behind in that position a compact little bunch of the outer ends of fine needles that accompanied their lost shafts as comitalia.

After full development, the hypodermalia have the paratangentials armed from base to tip with strong and sharply pointed prongs, arranged in two series along the lateral sides of the rays. The prongs are situated at tolerably regular intervals, those of the two sides alternating with one another. In the basal parts of the rays, the strongest prongs may be  $100\mu$  long ; there they all spring out nearly vertically but soon become bent in a claw-like manner, the bending taking place generally either backwards or forwards, and occasionally downwards away from the dermal surface. I do not remember ever to have seen the prongs bent upwards. Towards the tip of the rays and along with the gradual attenuation of these, the prongs grow continually smaller, and in the terminal parts they are simply thorn-like, being directed obliquely forwards. Apart from the above prongs, the surface of the paratangentials is perfectly smooth. The unpaired shaft-ray is never pronged ; it is entirely smooth except for a few microtubercles which may be present near its inner pointed end.

The *prostal pentaactins*, i.e., the hypodermalia after protrusion through the dermal layer, always show pronged paratangentials. The protrusion evidently takes place only after complete development of the armature, a fact which seems to hold true for all members of the genus. The paratangentials are, as measured on the prostalia, generally 5.5–6.5 mm. long and the shafts, 4.5–8

mm. Thickness of rays, not more than  $65\mu$  at base. The shaft may in length exceed the paratangential in the same spicule by about half the length of the latter; in other cases it is only about as long or even somewhat shorter. Compared with the same spicules of certain other species (*e.g.*, *R. capillatus*) in which they form a persistent veil, the shaft rays in the present species fall behind considerably in length, a fact which may have bearing on their tendency to be readily cast off.

The *dermalia* (Pl. XVIII., figs. 8–11) are predominantly rough stauractins. The center of these is generally plain but occasionally shows a gentle swelling on either the external or the internal side or on both sides. Rarely the dermalia are pentactins in which the unpaired ray is directed proximad while the distal ray is represented by a vestige in the form of a mere swelling. I have found the pentactinic forms especially along the hypodermal beams. Still more rarely are the dermalia diactins and tauactins, lying with all their rays in the dermal plane. In the former the suppressed rays are indicated by four knobs around the center; in the latter the atrophied paratangential usually leaves a knob-like relic, while the radial rays may or may not be similarly represented. Length of dermalia rays,  $114\text{--}194\mu$  (on an average  $156\mu$ ). Their thickness at base,  $9\frac{1}{2}\text{--}12\frac{1}{3}\mu$  (on an average  $10\mu$ ). Sides of the quadrate dermal meshes, on an average  $180\mu$ .

The *gastral* (Pl. XVIII., fig. 13) are rough hexactins in which the free proximal ray is not specially characterized. Length of rays,  $150\text{--}230\mu$  (on an average  $180\mu$ ); breadth at base,  $11\text{--}15\mu$  (on an average  $12\frac{1}{2}\mu$ ). Sides of the quadrate gastral meshes

average  $200\ \mu$  in length. Sometimes two gastralial may lie close together, in which case the directly adjoining gastral laths are three rays strong instead of two as usual. Unusually small and slender-rayed oxyhexactins occasionally present in the layer are without doubt gastralial which have not yet attained complete development.

Taking part in the formation of gastral laths, diactins are not infrequently found, the rays of which are generally somewhat thinner but longer than those of the hexactins. The center is marked either by an annular swelling or by four cruciately disposed knobs; the surface may be nearly smooth but is more generally roughened by the presence of microtubercles in varying numbers. There can scarcely be any impropriety in classing some at least of the diactins under the gastralial; at the same time they may be looked upon as spicules linking the gastralial proper to the hypogastralial.

*Oxyhexasters* (Pl. XVIII., figs. 5, 7 and 15) of a large size, measuring  $180\text{--}280\ \mu$  in diameter, are abundant in the choanosome. Normal forms are rather scarce; more frequently are the oxyhexasters hexactinose and most commonly, hemihexactinose. The principals are extremely short or nearly obsolete, making the terminals almost appear to radiate directly from the common central node. The terminals are strong, measuring up to  $4\ \mu$  in thickness at base; their surface is always rough, the roughness developing into small barbs in the basal parts. The uniterminal principal is either straight or bent at its junction with the terminal. In the former case the atrophied terminal may sometimes be represented by a unilateral boss (fig. 7).

In the normal oxyhexasters the number of terminals to each

and every principal seems to be generally two, giving twelve terminal points in all to the entire rosette. Quite rarely I have counted as many as fourteen terminal points, in which cases I presume one or two of the principals have had more than two terminals each. The hemihexactinose forms show 7–11 terminal points.

In one specimen I have noticed the presence in the subdermal space of a number of oxyhexasters, which, besides being normal, had appreciably thinner rays than others in deeper situations. Probably this differentiation of the peripheral oxyhexaster obtains in all individuals of the species, but is not always manifest owing to the sparseness of this kind of oxyhexasters in the periphery.

The *discoasters* (Pl. XVIII., figs. 6, 12) are of about the same size, and occur in nearly equal abundance, as the oxyhexasters. Diameter, 180–240  $\mu$ . Large and small discoasters occur together promiscuously. The central node is either plain or is supplied with the six hump-like prominences, the latter form being especially common in the case of the smaller of the rosettes. Principals smooth; about half as long as the terminal tuft; 5–7½  $\mu$  thick in the middle and somewhat thicker towards the outer end. Terminals slightly rough; gradually attenuating; nearly straight or just perceptibly bent after the manner of the latter S. Their number is 6–8, sometimes as few as 4, to a tuft, which expands gently towards the outer end. Terminal discs, minute and pinhead-like; not dentate.

*Microdiscohexasters* of the usual size and shape, most nearly resembling those of *R. mollis* (Pl. XX., fig. 4) or of *R. unguiculatus* (Pl. XXI., fig. 9), were found exceedingly sparsely in

one specimen. In other specimens I have sought after them in vain, though certainly I can not be quite sure that they were really totally absent in all these cases.

As to the *basidictyonal plate* of the species (Pl. XVIII., fig. 14), I have always found the structure to be thin and extremely uneven. The irregularly contoured beams are sparsely microtubercled. The meshes are small and roundish, oval or irregular in shape.

### Soft Parts.

A specimen of the size of an apple, killed and preserved in alcohol, was utilized for the study of the soft parts. However, this led to no important results. Not a little information as to the arrangement of the soft parts may be gathered from figs. 18-23 in Pl. XIX. and from the explanations appended thereto; and I here limit myself to recording some of the points determined, which are as follows:

Chambers,  $120\ \mu$  in average diameter. Meshes in their walls open, generally  $3-6\ \mu$  wide. Nuclei, about  $2\ \mu$  large in diameter; rather distinct though stained in about the same degree as the reticulum-forming protoplasm; containing one or more darkly stained granules. At the chamber-rim (fig. 19), as also along the termination of the chamber-layer close to the oscular edge (fig. 18), the finely reticular wall passes into film-like or filamentous trabeculae without any sharp demarcation. In the thin oscular margin the chamber-layer assumes the character of a continuous, irregularly undulating, reticular membrane, instead of being differentiated into separate chambers (fig. 18).



On several occasions I have distinctly observed the presence of a film-like *membrana reuniens* (Contrib. I., p. 130) filling up the gap between the circular apophyses of three or four, directly adjoining chambers (fig. 20, *f.*), thus shutting off at the spot the intercameral incurrent space from the excurrent lacunæ of the internal trabecular layer. At other times, however, the gaps were clearly seen to be open (fig. 20, *g.*), so that I believe the *membrana reuniens* is not a thing of constant occurrence.

Dermal and gastral membranes, rather extensively film-like (Pl. XVIII., fig. 16). Trabeculæ, thread-like; rather sparse in the subdermal space as well as along the lumen of both incurrent and excurrent canals. Their nuclei, at most  $2\mu$  in diameter; scattered at irregular intervals.

Archæocytes, found in small flat groups on the wall of chambers; not forming large congeries, which fact is probably due to the immature state of the specimen.

Scattered in irregular distribution and suspended on the trabeculæ, both external and internal, are found numerous fat-like spheres of various sizes (shown in figs. 20–22 as black dots). Diameter,  $7\frac{1}{2}$ – $20\mu$ . Sometimes they seem to be inclosed in a thin envelope; more often they are apparently quite naked. Their substance is either homogeneous or granular; it is intensely stained by carmine or hæmatoxylin, and is browned by osmic-acid but is not coloured blue by iodine. Neither alcohol nor ether dissolves it. I have therefore no doubt as to the bodies being thesocyotal products. Frequently two spheres are seen closely apposed to each other, as if they had taken origin and were actually lying together within one and the same cell,—which is probably the real fact, though the nucleus can not be distinguished.



Together with the above bodies or in places where one might expect to find them, there not uncommonly occur roundish, oval or irregularly contracted cells of pale appearance and each containing a darkly stained nucleus (fig. 20, *c.*). They measure  $7\frac{1}{2}$ – $12\mu$  or more across. An enveloping membrane is distinguishable; the contents are thinly granular. I take these cells for old thesocytes, which have lost the fat-like products by consumption.

### RHABDOCALYPTUS MOLLIS F. E. SCH.

#### Pl. XX.

*Rhabdocalyptus mollis*. F. E. SCHULZE, '86, p. 51; '87 (!), p. 155, Pl. LXIV; '97, p. 552.—I. IJIMA, '97, p. 50.—CH. GRAVIER, '99, p. 421.

The specimens I have seen of this species number not less than a dozen. Most of them belonged to Mr. ALAN OWSTON. That all came from the Sagami Sea there can be no doubt, but only in the following three cases can the localities be more exactly stated: Homba (about 572 m. depth), where KUMA obtained two very small specimens together with *R. capillatus*; off Odawara in the Province of Sagami (about 500 m.), at which locality I myself obtained a fragment attached, together with a number of other animals, to the carapace of a *Macrocheirus kempferi*; and the "Albatross" Station 3697 (about 4 kilom. off the mouth of Sakawa River in Sagami, 265–120 fms., black volcanic mud), where a tubular fragment of the species was trawled up by the "Albatross" (1900) together with *Acanthascus cactus*.

Nearly all of the specimens I have seen bore on the basal attachment samples of the bottom which consisted of a fine-grained, tufaceous clay.

I may begin the description of the general characters with the two little individuals (S. C. M. No. 421) mentioned above as having been obtained at Homba. Both are of about the size of a pea and are torn off at the base. They are both ovoid in shape and show a small round osculum. They possess some fine proctal needles together with a few proctal pentactins and are thus indistinguishable in outward appearance from the young of *R. capillatus* (Pl. XXII., figs. 3, 4).

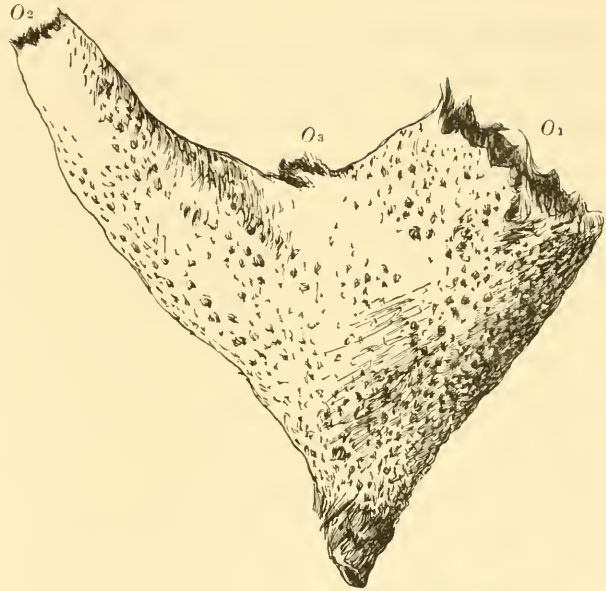
The species attains rather large dimensions. The individual shown in Pl. XX., fig. 1, which is one of the largest I have seen, measures 337 mm. in height and 6-8 mm. in thickness of the wall at most parts; that of fig. 2, same plate, 366 mm. in total height and 10 mm. in thickness of the wall in the inferior half of the body.

In general all the larger specimens are of a saccular, funnel-like or vase-like shape, gradually contracted towards the knobby base and more or less distinctly compressed in a lateral direction. In the specimen of Pl. XX., fig. 1, which, so much of it as is preserved, retains the natural shape in a perfect state, the osculum at the upper end is roundish measuring approximately 82 mm. in diameter; but a third of the height lower down, the body is sagittally 153 mm. and transversely 94 mm. broad; and still lower, the greater breadth is 82 mm. and the lesser, only 30 mm.

The species seems to be in a high degree prone to form secondary oscula; in fact all the large specimens I know of are in possession of one or more such in addition to the primary or main osculum. They may be represented by simple perforations

Text-fig. 9.—*Rhabdocalyptus mollis* F. E. SCH.  
(O. C. No. 104). Drawn  
in  $\frac{1}{4}$  natural size.

$O_1$ ., main osculum or  
osculum of the mother  
person.  $O_2$ ., osculum of  
the first-formed daughter  
person.  $O_3$ ., osculum of  
the second-formed daugh-  
ter person (injured).



Text-fig. 10.—*Rhabdocalyptus mollis* F. E. SCH.  
(O. C. No. 105). Drawn  
in  $\frac{1}{4}$  natural size.

$O_1$ -4., oscula num-  
bered in the order of  
their formation, as in the  
preceding figure.



but are more generally situated at the end of tubular outbulgings or buds of the sponge-wall. These are at first cæcum-like but after a time an osculum opens at the blind end of each; they, as also the simple secondary oscula, should be considered to represent daughter-persons formed by the mother-person, ill-defined and persistently continuous with the latter though they are. The bud may grow to conspicuous dimensions and thus may give to the sponge a very peculiar and characteristic shape. It seems to be invariably the rule that the simple secondary osculum or the tubular daughter-person, whichever be the case, arises at some point on one of the median edges—not on the broad lateral sides—of the laterally compressed mother-sponge, and that, when two or more secondary oscula or daughter-persons coexist, these are all situated in a row on the same body-edge.

My material comprises a series of specimens varying in the number of daughter-persons from one up to five.

The two specimens of Pl. XX., figs. 1 and 2, show each a single daughter-person. In the one (fig. 1) the wall is somewhat bulged out sagittally in the upper half of one of its obtuse edges. At the lower end of this out-bulging is an artificial gap in the wall, produced without doubt by the severing off of a daughter-person which had grown there. Assumably the upper part of the same out-bulging is in an inceptual stage of giving rise to a second daughter-person. The other specimen (fig. 2), a strongly laterally compressed individual, shows a conspicuous tubular daughter-person, 183 mm. long and springing from the upper part of the mother-wall in an obliquely upward direction. In this case we may presume, from the circumstances of space, that a second daughter-person, were it ever to arise, would be formed below the one already present. In the third specimen I have

seen with a single tubular daughter-person, this constituted a very conspicuous feature in that it was somewhat longer, though certainly less broad, than the mother-body. It arose from near the base, so that the formation of a future bud was to be anticipated most likely in a position above the daughter-person just referred to. That the second bud may be situated either above or below the first formed, is established by actual cases to be mentioned directly.

In text-figure 9 I have represented a specimen with two secondary oscula in addition to a large primary osculum ( $O_1$ ). Of the former, the larger one ( $O_2$ ) is situated at the end of a broad branch from the mother-body; it is evidently the older. The other ( $O_3$ )—the smaller and younger—is situated in the axil between the branch-like daughter-person and the mother-body; or, it would be proper to say simply that in that position is situated the second formed daughter-person which seems to have suffered much mechanical injury. The general shape of the sponge has been suggestively described by Mr. ALAN OWSTON as like “a hand with thumb extended.” Another specimen of essentially the same shape existed in the collection of the gentleman just mentioned. In it the second daughter-person was well-preserved in the form of a tube, smaller than the first daughter-person and situated between the origin of this and the oscular margin of the mother-person.

Here a reference may be made to the two specimens which are mentioned by F. E. SCHULZE in the Challenger Report. The smaller of them is said to have exhibited near the lower end two small roundish apertures. I consider it probable that these apertures were secondarily formed oscula or at any rate some sort of gaps indicative of daughter-persons. The other specimen,



which is figured, should have possessed on one side of the lower part a tube-like branch opening in a wide orifice at its extremity; directly below it a small caecal protrusion or boss; and just above the solid base a small round perforation in the body-wall. Whatever may be the nature of the last mentioned perforation, there can be no doubt about that of the tubular branch open at the end and of the caecal boss. The latter would after a time have developed an osculum at the blind end, like the older bud just above it.

The specimen of text-figure 10 bears three daughter-persons. The lowest, of a long tubular and chimney-like appearance, is without doubt the first formed ( $O_2$ ). As the second formed I consider the uppermost, a great part of which had evidently been torn off and lost, leaving an irregular gap in the wall ( $O_3$ ). Between the above two is the third tubular bud ( $O_4$ ) which is open at the end and is of a comparatively small size; this I regard as the one last formed.

Another specimen was essentially similar to the last mentioned except in the fact that it showed a distinct trace of the fourth bud which had been torn off. If it be justifiable, as in a great measure I think it is, to infer the order of successive formation from the relative caliber of the buds, then the lowest situated and by far the largest of them all is the oldest; the one directly above it, the third; next above comes the second; while the uppermost is the fourth and last formed.

A specimen with five well-preserved buds is distinctly bent in the sagittal plane. On the body-edge which formed the greater curvature the tubular buds are arranged in a row, after the manner of glove-fingers. Counting from below upwards, the first (the lowest) bud is very long, chimney-like and open at the end; this is probably the oldest daughter-person. The second resembles



a tube only about half as long as the first and still closed at the tip. The third is a long tube, broader but slightly shorter than the first and open at the end; this I regard in point of age as next to the oldest daughter-person. The fourth is a relatively short blind tube like the second. Finally the fifth, *i. e.*, the uppermost situated near to the margin of the main osculum, is a tube of about the same size as the last but open at the end; it probably represents a daughter-person younger than the third but older than either the second or the fourth, both of which terminate in a cul-de-sac indicative of their incomplete development and may have originated nearly simultaneously.

Thus far concerning the peculiar external shape which the species may acquire as the result of budding out tubular daughter-persons.

Now, the gastral cavity of the mother-person—it is scarcely necessary to say—is directly continuous with the like cavities of the daughter-persons. It is very deep and extends close to the basal attachment, so that a solid stalk can certainly not be attributed to the species. Externally, the circumference of the basal attachment may show irregular pad-like thickenings.

The oscular margin, which is always thin, is generally simple-edged in the daughter-persons. That of the mother-person may, on the other hand, show a varying number of fine, short prostal needles, projecting upwards to a length not exceeding 5 mm. These partly springing from the very edge and partly from the dermal surface adjoining it, may form an inconspicuous and interrupted fringe to the osculum. That diactinic prostalia occur with comparatively greater prominence in the young stage of the sponge, may be concluded from the condition presented by the two very small individuals before mentioned.

As in *R. victor* the proctal pentactins seem to fall off readily. Thus, in the specimen of Pl. XX., fig. 1., in which the external surface is in an almost perfect state of preservation, the pentactins, protruded to an extent of 3 or 4 mm., occur isolatedly and sparsely in certain parts only, while over the greater part of the sponge they are totally missing.

The delicate dermal lacework is thrown into little creases, possibly as the result of desiccation. Observed under the lens the meshes appear to be irregular and indefinite in shape, which is due to the fact that the dermalia are diactins that cross, or are joined to, one another at various angles (Pl. XX., fig. 12). The thin and wavy hypodermal strands, in places so thin as even to closely resemble the dermalia in strength, form also irregularly angulate, but of course much larger, meshes. They are seen, sometimes with a fair degree of distinctness, to converge towards separate central points which are 3–6 mm. apart. This is on account of the pentactinic hypodermalia being arranged in groups, much as we have seen them in *R. victor*. In the lower parts of the sponge, especially near the base, the centers of the hypodermalia groups are usually well indicated by short small projecting tufts of fine needles which either cohere or are loose and brush-like. The same tufts we have likewise seen in *R. victor*. The proctal pentactins that may occur spring out in connexion with the tufts.

In one specimen I have seen on the dermal surface several cicatrice-like spots which appeared white and densely textured. The same have sometimes been noticed in several other Acanthascinae. It is more than probable that they arise by hyper-regeneration of tissues, both soft and scleric, at places where the sponge had suffered an injury.

The internal surface of the sponge-wall is covered throughout with a continuous gastral lacework, in which the meshes, for the most part regularly quadrate in shape, can be discerned with the naked eye (Pl. XX., fig. 13). Beneath the layer are seen hypogastral strands varying in thickness, running in indefinite directions and intersecting one another at various angles.

The canals, both incurrent and excurrent, are deep and pit-like. In the larger specimens, the roundish canalar apertures of the incurrent system may be as large as 4 or 5 mm. in diameter, while those on the gastral surface measure at most 2 mm. The latter are thus on the whole smaller than the former but are situated more closely together (Pl. XX., fig. 2). On cross-sections of the sponge-wall, the canals of the two systems do not alternate so regularly as in certain other species in which they are of approximately the same caliber.

### Spiculation.

With F. E. SCHULZE's excellent descriptions of the spiculation of this species and with two slide preparations from the type specimen which he gave me, it was an easy matter for me to recognize the species.

The *principal parenchymalia* are bow-like oxydiactins which may be 20 mm. long and 90  $\mu$  thick in the middle but are more generally smaller. The middle is not externally marked by swellings. The rays are gradually attenuated toward the end.

The smaller parenchymalia, down to comitalia of only 4  $\mu$  thickness, are of the usual description. A central nodal thickening

is by no means of such frequent occurrence as one might be led to suppose from F. E. SCHULZE'S statement in the Challenger Report. The tips are acuminate, rounded, conical or mucronate; occasionally swollen to a club-like or even a bulbous shape. Subterminally rough in varying degrees; the microtubercles, when strongly developed, are retroverted.

The parenchymalia undergo synapticular fusion close to the basal attachment and in conjunction with the basidictyonalia. In certain specimens the fusion was limited to the central parts of the base; in others it extended to the external surface.

The *basidictyonal* plate is at places represented by a very thin reticular layer quite agreeing in appearance with F. E. SCHULZE'S Pl. LXIV., fig. 3, in the Challenger Report. At other places it is of a considerable thickness, being composed of basidictyonal hexactins ankylosed together in the usual manner.

The *hypodermal* pentactins show essentially the same characters and arrangement as in *R. victor*. Paratangentials, not exceeding 5 mm. in length; the shaft, longer, up to 10 mm. The former are more or less paratropal, but cases of their being quite or nearly regularly cruciate are not infrequent. This may be explained by the fact that the hypodermalia do not lie close together in their groups (Pl. XX., fig. 12) and consequently their shafts run a certain distance apart from one another, thus departing in a measure from the condition that causes the paratropism in a developing hypodermal pentactin. Not uncommonly four or five pentactin-heads are seen in a group, of which the most superficially situated (*i. e.*, the oldest) one or two have the four paratangential rays provided with the spiny armature. The spines

are somewhat less developed, with respect both to their size and number, than in *R. victor*. They are directed obliquely outwards, the stronger ones in the basal parts of the rays being curved generally likewise outwards but occasionally in some other direction, in a claw-like manner. Though arranged as a rule in two irregular series on the lateral sides, there may occasionally exist a spine or spines on the external side of the ray, especially in the basal parts. The spines on the two sides may alternate with tolerable regularity, but this is subject to frequent interruptions. Those on the same side are situated at intervals which frequently may measure  $160\ \mu$  or thereabout.

In some cases—not all—of the spined hypodermal pentaetins, I have found the general surface of the paratangentials to be finely shagreen-like on account of the presence of dense microtubercles, similar to those in certain *Staurocalyptus* species. In this, as also in several other features of the spiculation, the present species stands in very close agreement with *R. australis* Tors.

A number of slender diactins, indistinguishable from parenchymalia of a similar strength, associate with the paratangentials in forming the hypodermal strands. A number of comitalia accompany the shafts.

The *dermalia* (Pl. XX., fig. 12) are generally rough and rod-like diactins, much like those given in Pl. XXI., fig. 2 (from *R. unguiculatus*). Rarely and exceptionally are they orthodiaetins, tauactins, stauractins or pentaetins. According to F. E. SCHULZE monactins should occasionally occur also.

The diactins, which are either straight or very slightly arched, are  $265\text{--}485\ \mu$  long as measured from tip to tip. Breadth



in or near the middle,  $9-15\mu$ . The spicular center is generally plain; otherwise it is externally marked, sometimes by an annular swelling and sometimes by knobs which may occur either in a single pair or in two pairs. The rough-surfaced rays generally taper slightly towards the tip which is rounded off or conically pointed.

The *gastralia* (Pl. XX., fig. 13) are hexactins with rays appearing exactly like those of the dermalia. Length of rays,  $165-245\mu$  (about  $200\mu$  on the average). Breadth at base,  $11-15\mu$ . All the six rays in the same spicule may in general be said to be nearly equally long, though in some cases the distal ray has been found to be somewhat shorter, and the free proximal ray to be somewhat longer, than the paratangential rays. The microtubercles may be slightly more pronounced on the proximal ray than on any other, but in any case the differentiation of that ray is never carried out to any considerable degree. The unusually small and slender-rayed gastralia, which are occasionally met with, are apparently those that have not yet attained full development.

The *oxyhexasters* occur much more abundantly in the deeper parts of the wall than in the periphery, as has been pointed out by F. E. SCHULZE. Diameter,  $102-160\mu$ ; usually about  $120\mu$ . The microtubercles on the basal parts of terminals show the tendency to develop into barbs in an unusual degree.

One point concerning the spicules, which has not been mentioned by F. E. SCHULZE, is the fact that they occur in two slightly differing forms, the one chiefly in the subdermal space and the other in more deeply situated parts. It must however be said at once that the two varietal forms intergrade.



The subdermal oxyhexasters (Pl. XX., fig. 3) are distinguished by being nearly always of the normal shape and by having very slender terminals. Each exceedingly short principal in a spicule carries 2-4 (usually 3), nearly straight, rough terminals. These seem to be very fragile; the broken off terminals are usually found in numbers sticking to the dermal membrane. The roughness of surface becomes more pronounced towards the base of the terminals, where it may distinctly appear to be due to reverted microtubercles. Under certain circumstances these may be developed even into long and conspicuous barbs, but such is by no means the case with the generality of the peripheral oxyhexasters. Rarely is the variety in question hemihexactinose or hexactinose. Deep in the choanosome it is only occasionally met with promiscuously with the following.

The second variety (Pl. XX., figs. 6-11) is by far the more numerously represented, occurring in greatest abundance in the subgastral region as well as in the endosomal layer. In it the principals are reduced almost to nothing, so that the terminals appear to radiate directly from the central node. The terminals are—in some individuals of the sponge slightly and in others decidedly—stronger than in the other variety. In some exceptional cases of the spicule I have found all the rays nearly or quite smooth from tip to base; but the general rule is that their basal parts show a varying number of barbs or unusually strongly developed retroverted microtubercles, while the distal parts are either obsoletely rough or quite smooth. Sometimes the basal barbs occur in quite a limited number; it may even happen that in the same spicule some rays are provided with only a few of them while the rest are entirely smooth. As a general rule, however, the barbs are numerous, gradually increasing in length

towards the very base of the ray to which they belong. As has been known from F. E. SCHULZE, the more basally situated barbs may sometimes be so long that those of adjacent rays almost unite. In a few instances I have seen some of the barbs of the different rays actually in fusion, thus producing around the central node a structure which bears a certain resemblance to a lychnisc.

The total number of rays in an oxyhexaster of the second variety may be twelve or even thirteen or fourteen. These evidently represent cases of normal oxyhexasters, in which the six, nearly suppressed principals are either all biterminal or are partly biterminal and partly triterminal. On the other hand a large, if not the greater, number of the oxyhexasters in question are apparently hemihexactinose, leading down to the quite hexactinose forms which are also numerous represented. Both the reduced oxyhexasters just named are of the usual general shape and need not be specially described. But I should mention that again in this species I have encountered several instances of a principal bearing divergently a well developed terminal and the spurious rudiment of a second (Pl. XX., fig. 10). The rudiment may occur as a small unilateral spine even in the cases in which the principal and the persistent terminal have straightened out as a simple ray, not bent at the base (Pl. XX., fig. 7).

F. E. SCHULZE has found in some numbers peculiar oxyhexasters—reduced forms with six or less rays in all—in which all or some of the rays present are spirally twisted (Chall. Rep., Pl. LXIV., figs. 10 and 11). A similar oxyhexaster was noticed by me in *Staurocalyptus pleorhaphides* also (p. 229, Pl. XVI., fig. 8). As regards the present species, certain specimens indeed were found to possess the twisted oxyhexasters though sparingly, but in several others I have searched for them in vain. I am there-

fore disposed to consider them as of inconstant occurrence in the species. Possibly they are produced only under certain abnormal conditions.

The *discoctasters* (Pl. XX., fig. 5) are found scattered in the wall, but in especial abundance in the subdermal space as was noted by F. E. SCHULZE. I may here note that contrariwise in *R. capillatus* the same spicule is most numerous in the subgastral region. What causes such a dissimilar distribution can certainly not be told. In diameter the spicules in question vary from  $130\ \mu$  to  $175\ \mu$  (on an average  $140\ \mu$ ). They are nearly as large as, or but slightly larger than, the average oxyhexasters of the species. The central node exhibits the six hillock-like prominences more or less distinctly. The principals (secondary) take up about one-third or less of the entire ray-length; they are  $5\ \mu$  or more thick in the middle. Number of terminals in a tuft, 5-9; rarely as few as 3 or even 2. The tuft is gently expanded distally, the terminals composing it being each slightly bent outwards or, as is sometimes the case, nearly straight. The surface of terminals is slightly rough; under the immersion system the roughness may be seen to be caused by reverted microtubercles. The terminal discs are either simply pinhead-like or show seven or eight marginal teeth, the latter being the case in the larger discoctasters.

Not infrequently are the discoctasters malformed in that some terminals remain free without being incorporated into any of the secondary principals. Noteworthy seem the few instances that came under my observation, in which the terminals stood out in eight tufts directly from the tubercled central node, without coming into fusion in the basal parts.

The *microdiscohexasters* (Pl. XX., fig. 4) are of the familiar appearance. Diameter, 22–27  $\mu$ . F. E. SCHULZE found these spicules in especial abundance in the proximity of the dermal membrane. In the preparations that he sent to me I find them quite common in the endosome as well as in the subgastral region, once counting as many as a dozen in the same visual field of the microscope. Far less commonly and even quite sparsely were they represented in several specimens in which I have specially looked for them. In these they were to be met with only now and then, both subdermally and subgastrally.

### **RHABDOCALYPTUS UNGUICULATUS** NOV. SP.

#### Pl. XXI.

The species here described as new under the above name is unquestionably a very near relative of *R. mollis* F. E. SCH. and of *R. mirabilis*. From both these species it can scarcely be said to differ so far as the categorical forms of the spicular elements are concerned; but in the details of characters I find, common to all the individuals referred to it, certain constant peculiarities which, I think, may be considered to be of specific value.

I have had at my disposal for examination no less than eight specimens, all of which I place under the present species. The known locality is Okinosé, both Inside and Outside; depth, about 500 m.

Three of the said specimens are small, young individuals, quite similar in external appearance to the young of *R. victor*

(Pl. XIX., fig. 17) or of *R. capillatus* (Pl. XXII., figs. 3-5). Two of them grow together on a mass of coal-cinder in company with the large and beautiful specimen shown in Pl. XXI., which will soon be described in detail as the type of the species. A fifth specimen (S. C. M. No. 473) shows a tubular shape, 58 mm. high. A sixth (S. C. M. No. 402), 100 mm. high, is much macerated; it is attached to a branch of *Ceratoisis* sp. together with a small *R. victor*. Finally two more specimens, which belonged to a collector, came under my inspection; they were both tubular and somewhat fusiform, measuring respectively 115 mm. and 150 mm. in height. These two also grew on a piece of coal-cinder, erect and side by side. In the gossamer-like covering and in other points of the macroscopic characterization, they agreed well with the type-specimen. In no specimen have I seen any indication of the formation of secondary oscula or daughter persons.

The type-specimen referred to above (Pl. XXI., fig. 1; S. C. M. No. 501, from Outside Okinosé) is an exquisitely preserved individual of the shape of a thick-walled, somewhat laterally compressed, tubular sac, gently swollen out on the sides. It is attached to the substratum by an irregular basal mass, situated on one side of the lower end and as usual in the sagittal plane of the body. Total length, 365 mm. Breadth in the middle (exclusive of the layer of prostals), 140 mm. sagittally and 120 mm. transversely. Thickness of wall in the same position, 21 mm.; it is much greater than in specimens of *R. mollis* of approximately the same size. The oval osculum at the upper truncated end, 72 mm. by 107 mm. in diameter.

In the peristomal region there exist numerous, fine, needle-like oxydiactinic prostalia of variable length. They may project



to the length of 14 mm. or more. They spring out partly isolated and in irregular distribution but more usually in tufts from the top of little tubercle-like prominences of the dermal surface. Within a centimeter's distance from the oscular edge the oxydiactinic prostalia become entirely replaced by large oxypentactinic ones, which cover the rest of the external surface down to the basal mass. All the pentactins arise in tufts from the summit of small tubercle-like or papilla-like prominences, which are always of small diameter but may sometimes be 2-3 mm. high. They are usually separated from one another by a space of 5-10 mm. In many cases there are only two or three pentactins in a tuft; in other cases there may be more than ten. The paratangential heads in a tuft do not all lie in the same level but usually rise to various heights from the dermal surface, representing different stages of the protrusion of the shafts from the latter. Thus, there arises the gossamer-like layer, in places 15 mm. thick, over the sponge exterior. The conditions of the prostalia are exactly the same as in *R. capillatus* (cfr. Pl. XXII., fig. 12, etc).

On the basal mass there bristle out numerous hair-like prostals. These, on close observation, were found to be simply the shafts of such prostal pentactins whose distal parts had been broken off.

The dermal surface is rather uneven. Under the lens it shows the dermal layer to be irregularly meshed, which is due to the diactinic dermalia. The comparatively fine hypodermal fibers exhibit a certain regularity of arrangement in so far as they appear to radiate from the base of each prostal tufts. In short, the structure of the ectosomal skeleton is essentially the same as is known to me from *R. mollis* and *R. capillatus*.



The subdermal space presents itself as a rather conspicuous layer in sections of the wall. In places it is as much as 3 mm. across. It is traversed by the pillars which join the ectosome to the choanosome and consist mainly of the shafts of prostal and hypodermal pentaetins and of their comitalia. The appearance of the wall in section partakes much of that which I have figured from *R. capillatus* in Pl. XXII., fig. 12.

As to the roundish apertures of the incurrent canals a certain difference is noticeable with respect to their size and manner of distribution on the two lateral sides. On the side shown in Pl. XXI., fig. 1, some of them measure up to 7 mm. in diameter, and lie promiscuously with others which are at most about half, and often much less than half, as wide. On the other side the apertures are of a more uniform size, mostly measuring 3–5 mm. in width and situated somewhat more closely together.

The gastral surface is covered over by a continuous gastral lacework, the regularly quadrate meshes of which are plainly visible to the naked eye. They are much larger than in *R. mollis* or *R. capillatus*, measuring  $\frac{1}{2}$ – $\frac{1}{2}$  mm. in length of sides. In the interspace between the excurrent canalar apertures, the layer is in tolerably close contact with the choanosome; over the apertures it frequently heaves up in a vault-like manner. Remarkable is the fact that even over the largest apertures there are seen no hypogastral strands in support of the gastral layer.

The excurrent canalar apertures in most parts of the gastral cavity are rather closely set, reaching up to 5 or 6 mm. in diameter. In the bottom of the cavity some of them are as wide as 8 mm.

### Spiculation.

The following account is based on my observations on the type specimen, except when other specimens are specially referred to.

The *principal parenchymalia* are large oxydiactins which may measure 30 mm. in length and  $175\mu$  in breadth in the middle. They are generally more or less bent and gradually attenuated towards both ends, which are rough for a short distance even in the largest of the spicules. The accessory parenchymalia present no point that seems to require special mention.

The *proctal oxydiactins* of the marginal zone may attain a length of 25 mm. and a breadth of  $85\mu$  in the middle. They are smooth throughout, without any indication of the spiny character of the distal parts, such as has been observed in *R. mirabilis*.

The *proctal oxypentactins* have paratangentials which are nearly always paratropal and are 8–11 mm. long and about  $85\mu$  broad near the base. The spines on the paratangentials may be as high as  $150\mu$ . Basally on the rays they are rather irregularly disposed but more distally are arranged in two lateral rows. The smooth shaft-ray generally measures 15 mm. or over in length. On the basal mass of the sponge it may be as long as 40 mm.

With respect to the arrangement of the same oxypentactins as *hypodermalia* and of the younger spineless hypodermal oxypentactins, what I have said under *R. victor* may be considered to apply equally well to the present species.

No diactins seem to occur as hypodermalia, unless those that occasionally extend from the choanosome into the ectosome or unless those which will presently be mentioned as unusually elongate dermalia be regarded as such.

The *dermalia* (Pl. XXI., fig. 2) are nearly exclusively diactins and only occasionally stauractins or tauactins. The rays are rough all over and slightly tapering towards the rounded or obtusely conical end. The diactins are nearly straight or only perceptibly arched. In them the center is usually not marked by any swelling; only occasionally it is indicated by two opposite lateral tubercles, never by four such in cruciate disposition,—a fact which suggests the direct derivation of the diactins from stauractins and not immediately from either pentactins or hexactins. The diactinic dermalia generally measure 330–420  $\mu$  (about 400  $\mu$  on an average) in total length and 8–15  $\mu$  (about 10  $\mu$  on an average) in thickness near the middle. Rarely there occur, among the dermalia, diactins, 800  $\mu$  or nearly 1 mm. long. With such an increase in length of the dermalia, the roughness of the surface shows a tendency to become confined to the terminal parts, leaving the middle parts smooth.

The *gastralia* (Pl. XXI., fig. 3) are rough oxyhexactins of much greater axial length than the dermalia. They are considerably larger than the same spicules of *R. mollis*. The radial axis is 640–850  $\mu$  (on an average about 780  $\mu$ ) long. Length of the free proximal ray, 440–550  $\mu$ ; that of the distal ray, 230–300  $\mu$ ; that of paratangentials, 275–330  $\mu$ . Thickness of rays near base, about 15  $\mu$  on the average. The proximal ray, which is not only the longest but generally also the thickest of all in

the same spicule, shows no swelling in its course but gradually tapers like the rest of the rays, whereas in *R. mirabilis* the same ray should be thickened in the middle. The microtubercles on that ray are more numerous and somewhat more strongly developed than on all the other rays on which they appear rather sparsely.

The *oxyhexasters*, which occur abundantly in all parts, measure 130–160  $\mu$  in diameter. Those situated in the periphery of the wall are mostly normal, having usually two and occasionally three, slender (about 2  $\mu$  thick at base) and obsoletely rough terminals to a principal, the latter being very short (Pl. XXI., figs. 4 and 5). It seems that the terminals are very easily broken off at base, for it is seldom that one meets with an oxyhexaster of this variety in a perfectly intact state.

In the deeper parts of the wall the oxyhexasters change in their character, though in general size there exists no appreciable difference (Pl. XXI., figs. 6–8). Thus, in the subgastral region as well as in the endosome they are scarcely ever normal but are nearly always hemihexactinose and occasionally regularly hexactinose. Moreover, the terminals are quite smooth throughout and are considerably stronger than in the peripheral oxyhexasters. —sometimes fully twice as thick at base as in the latter. The exceedingly short principals bear at the most two terminals.

The *discoasters* (Pl. XXI., figs. 10 and 11) resemble in shape and size those of *R. mollis* or *R. mirabilis*. They are found more abundantly in, as well as directly under, the ectosome, than in the deeper parts. Diameter, 175–190  $\mu$ . The six bosses on the central node are sometimes distinct and sometimes not,

The principals are  $20-25\mu$  long as measured from the spicular center,—in any case they are much longer than in *R. mirabilis*; they are of uneven contour and slightly swollen towards the outer end (about  $10\mu$  thick). The terminals number 7–12 to each principal and form a rather broad, lily-like tuft, expanded at the outer end to a breadth of about  $60\mu$ . Each single terminal is nearly smooth, rather strong, thickens slightly near the distal end and terminates with a small disc of a characteristic shape. This disc distinctly shows some recurved marginal teeth, which are however not uniformly developed, but are longest and strongest on that side of the disc which is turned away from the axis of the perianth-like tuft of terminals. On the opposite side of the disc, *i.e.*, the part of the disc circumference nearest the axis, the teeth are smaller and often obsolete or even totally suppressed (fig. 11). Thus, the disc approaches or factually assumes *en miniature* the shape of the unguiculate terminal plate in an Euplectellid floricombe. The teeth, when present all around, number six, but there may be only the three or four on the external side of the disc. In width the disc may measure about  $7\mu$ , of which nearly  $4\mu$  constitute the length of the longest tooth.

*Microdiscohexasters* (Pl. XXI., fig. 9) of  $22-30\mu$  diameter are sparsely distributed in the dermal membrane. They are of the usual description.

And now a few words about the *basidictyonal plate* (Pl. XXI., fig. 12). This consists as usual of a thin limiting plate, inside of which are found some small but thick-rayed hexactins in fusion with it. The uneven and irregularly cribrate limiting plate shows roundish meshes, generally under  $35\mu$  in width; its



beams,  $25\mu$  or less in thickness, are sparsely microtubercled and contain, here and there in the nodes, axial canals in the form of a plane cross. The basidiectyonal hexactins are likewise sparsely microtubercled. There can be scarcely any doubt that these are the same as those which F. E. SCHULZE ('99, p. 63) discovered forming a rigid framework in the buds of *R. mirabilis*.

Finally it should be stated that the spicules, as might be expected, are subject to certain variations according to the age or the individuality of the sponge. Thus, in a young specimen not larger than a nut and attached to the same piece of coal-cinder as the type specimen, I find several of the spicules considerably smaller than those mentioned above. They measure as follows: Paratangentials of prostal pentactins not over 5 mm. in length; dermalia  $275-330\mu$  (on an average  $320\mu$ ) long and generally about  $7\frac{1}{2}\mu$  thick in the middle; proximal ray of gastralia  $330-385\mu$  long; paratangentials of same  $187-240\mu$  long; diameter of discoctasters  $143-155\mu$ ; principals of same about  $19\mu$  long; etc. In a certain specimen I have found the terminals of oxyhexasters sparsely microtubercled at the base, instead of being entirely smooth.

### **RHABDOCALYPTUS CAPILLATUS IJ.**

Pls. XXII. and XXIII.

*Rhabdocalyptus capillatus*. I. IJIMA, '97, p. 51.

Of this species some sixteen specimens of various sizes have thus far been examined by me. The known localities are:



Maye-no-Yodomi ; Mochiyama ; Inside Okinosé by the Ena-line ; Outside Okinosé by the Iwado-line ; and Homba ;—all in the Sagami Sea. Depth, between 500 and 572 m. (274 and 313 fms.). The samples of the bottom found attached to some of the specimens are tufaceous. In one case six small specimens were found seated on a dead *Chonelasma calyx* from Maye-no-Yodomi. Another dead *Chonelasma calyx* from Mochiyama bore three young individuals of the species together with two of *Staurocalyptus glaber*.

The smallest specimen I have had was globular in shape, measuring only about 3 mm. in diameter. It already possessed a small osculum, while from its surface there emanated, almost radially, a number of fine prostal diactins that stood out isolated. These were the only prostalia to be seen on it.

The next larger specimen, shown in natural size in Pl. XXII., fig. 3, is barrel-like ; it shows in addition to prostal diactins some small pentactinic prostalia. But these are as yet quite few in number.

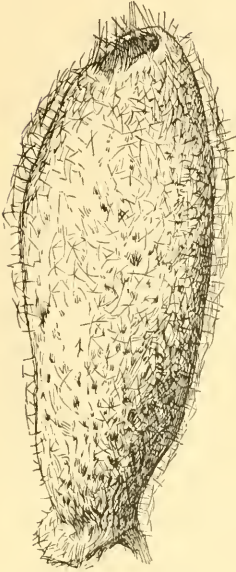
Young specimens (figs. 4 and 5), still larger but under 30 mm. or thereabout in height, may be said to retain the barrel-like shape, the cross-section of the body being of an approximately circular outline. Both the diactinic and the pentactinic prostalia have greatly increased in number. The former are more abundant in the upper parts of the body than in the lower, being most numerous in the marginal zone around the circular osculum. The latter are present all over the body, mostly arising in tufts from slight elevations of the dermal surface. The general appearance of young individuals closely resembles that of *R. victor* of about the same size, so that in their cases the microscopic examination of the spicules is quite indispensable to insure correct identification.

After attaining a moderately large size, the body is pouch-like, tubular or vase-like, and laterally compressed to a greater or less degree. The wall is moderately thick. The deep gastral cavity extends close to the basal attachment. Pl. XXII., figs. 1 and 2, and text-figure 11 will serve to give a fair idea of the external appearance of what I consider to be quite or nearly mature specimens.

Fig. 1 shows a specimen—from Inside Okinosé by the Ena-line—of a strongly laterally compressed pouch-like shape. Height, 97 mm. Breadth sagittally, 40 mm. at the attachment base and 77 mm. in the broadest part. The osculum is slit-like and comparatively small, occupying a position at one end of the upper body-edge, the other end of which forms a part of a rounded outbulging of the wall. This outbulging shows a small perforation at the top besides a thinning-out of the wall at two places. It contained in the internal cavity a cluster of Cephalopod eggs in which the embryonal development was still in an early stage and which therefore could not have been there long enough to justify the assumption that their presence had acted as the cause of the outbulging.

The specimen shown in fig. 2 is from Outside Okinosé. It is one of the largest I have seen, measuring 210 mm. in height. The lower half of the body is distinctly compressed laterally, the breadth measuring 90 mm. sagittally and 50 mm. transversely. The upper parts are swollen, the osculum being roundish with a diameter of about 45 mm. Thickness of the wall in the middle of the body, about 14 mm. (exclusive of the gossamer-like layer of prostals). The basal attachment is at one corner of the lower end. In the angular corner opposite to this opens a small secondary osculum of an irregularly oblong shape. On one side of the speci-

men there is a large cicatrice-like patch where the wall is very thin, probably the result of the healing of an injury received there.



Text-fig. 11.—*Rhabdocalyp- tus capillatus*.  $\frac{1}{3}$  natural size.

The annexed text-figure 11 represents another large specimen which belonged to Mr. ALAN OWSTON (O. C. No. 102). The shape is that of a spindle-like vase, standing erect and but little compressed laterally. Height, 210 mm. Breadth, 72-79 mm. in the middle. Thickness of wall in the broadest part, 7-16 mm. The irregularly shaped osculum at the narrowed upper end is 35 mm. long and about 20 mm. broad. The body likewise narrows below but somewhat expands again at the very base.

In all the larger specimens, the distribution of diactinic prostalia is confined to the oscular edge and to a narrow zone along it. I presume that in this species, as in *R. victor* and *Staurocalyp- tus glaber*, the early formed diactinic prostalia of the young are cast off and thus become lost during growth, though new spicules of the same kind continue to be produced in the growing parts, *i. e.*, in the oscular margin. Here the spicules spring out either singly or in small tufts. In the latter case they generally arise from the apex of small dermal elevations, the same as those which, lower down in the body, bear the tufts of pentactinic prostalia. The marginalia project generally straight upwards to a length of 7-12 mm. and taken together may form a bristly wall around the oscular opening. The secondarily formed osculum is provided with none or at most with only a few of such marginalia.

All the rest of the external surface is thickly covered with large or moderately large pentactinic prostalia, forming a persistent gossamer-like layer much as we have seen in *R. unguiculatus*. The layer, which may be 9 mm. thick, is sufficiently resistant to allow handling the specimens without touching the dermal surface. The pentactins arise invariably in tufts, often ten or even more in number to each, situated at intervals of 4–10 mm. from one another. The ectosome projects at the tuft-basis in the form of a narrow papilla-like prominence which may be 2 mm. high (Pl. XXII., fig. 12); and this prominence always occupies a position central to each irregularly radiating group of hypodermal fibers (=paratangentials of hypodermal pentactins; same plate, fig. 16). In the prostal tufts the different paratangential heads usually lie at various distances from the dermal surface, according to the order in which their successive protrusions took place.

In certain specimens I find in some places a film-like substance stretching in streaks and patches between the prostalia. The presence of nuclei in it can not be demonstrated and there can be little doubt that it represents something—probably mucous—foreign to the sponge.

The dermal surface is rather uneven. As in all species with diactinic dermalia, the dermal meshes are observed under the lens to be irregularly shaped,—not quadrate. The layer is supported by the intersecting hypodermal fibers already referred to (fig. 16).

There is a comparatively wide subdermal space, traversed by the shafts of hypodermalia and prostalia and also by the distal ends of certain parenchymalia. On sections of the dried body-wall it plainly presents itself to the unaided eye as a layer which may be 1–2 mm. wide.

The roundish entrances into the incurrent canals are on the whole rather wide. In large specimens they may attain 4 or 5 mm. in diameter, those of nearly similar sizes being separated from one another by an interspace measuring in width nearly as much as their own diameter.

The entire inner surface of the wall is covered by a gastral lacework with regularly quadrate meshes of  $130\text{--}240\ \mu$  (on the average  $175\ \mu$ ) on a side. When viewed in an oblique direction under the hand-lens, the gastral layer presents a velvety appearance on account of the projecting proximal rays of the hexactinic gastralialia. Directly beneath it are distinctly observable hypogastral strands of varying strength. They run in various directions and by intersecting form wide and irregularly shaped meshes. As usual they are frequently seen to stretch right across the excurrent canalar apertures. The stronger strands may push out the gastral surface in a ridge-like line.

A somewhat different state of the gastral surface obtains in very small young specimens. Until these have grown to a certain size, the gastralialia are not present in numbers sufficient to form a continuous layer. Hence, there occur between them gaps by which the excurrent canals open directly and freely into the gastral cavity. The little specimen of Pl. XXII., fig. 3, still exhibits this condition of the gastral surface; whereas, that of fig. 4 is already in possession of a continuous gastral layer covering the apertures of all the excurrent canals.

These, in large specimens, are smaller than the average incurrent apertures on the external side, generally measuring 2–3 mm. in diameter. They are closely packed together.

The main canals, both incurrent and excurrent, are pit-like



and deep. On sections of the wall it is easy to make out that those of the two systems alternate (fig. 12).

### Spiculation.

The *principal parenchymalia* are slender bow-like oxydiactins, reaching up to 24 mm. length and  $132\mu$  in thickness at the middle. The gradually tapering rays are subterminally more or less rough. Of the more slender parenchymalia I see no points worth special mention.

The *hypodermalia* consist of large or moderately large oxy-pentactins with paratropal paratangentials which may reach 12 mm. in length and about  $55\mu$  in thickness at base. The shaft, up to 15 mm. in length, is always the longest of all the rays; it is smooth except at the end which is somewhat rough. The paratangentials are likewise smooth in the incompletely developed state of the spicule, but finally acquire the spiny armature characteristic of all *Rhabdocalyptus* species. The stout conical spines occur here in a rather irregular distribution—at any rate, not strictly in two lateral rows—at intervals varying from  $70\mu$  to  $200\mu$ . Those situated on the basal parts of the rays may be  $80\mu$  long, springing at first vertically and then becoming more or less bent in an indefinite direction. Towards the end of the rays they become shorter and more slender, being pointed obliquely away from the spicular center. Exactly as I have enunciated under *R. victor* (p. 243), the hypodermalia occur in close groups of two or more—frequently as many as eight or nine,—the paratangential heads in each group forming hypodermally an irregularly radiate system



of fibers (Pl. XXII., fig. 16). In each such system, the most superficially situated head or heads, generally 1-3 in number and belonging to the oldest hypodermalia in the group, consist of rays which exhibit the spines; all the more deeply lying and successively younger heads are made up of smooth rays. From the center of the radiate hypodermal system arise the prostalia in a tuft, the base of which is enveloped in the papilla-like prominence of the dermal surface. A number of comitalia accompanying the shafts and those of certain more or less radially disposed parenchymalia extend their distal ends into this papilla-like base of the prostalia. The prostal pentactins, being nothing else than old hypodermal pentactins protruded through the dermal layer, need not be specially described.

Diactins do not seem to associate with the hypodermal paratangentials in forming the support to the dermal layer.

It may be worth mentioning here that in the smallest specimen I have had—measuring only 3 mm. across the body—the small hypodermal pentactins were all found to have regularly cruciate paratangentials. This may be explained by the fact that they were situated isolatedly and hence there were wanting in their close proximity shafts of older pentactins, the presence of which shafts should cause the paratropism of the younger pentactin-heads. None of the hypodermalia in this little specimen were protruded as prostalia, nor were any of them as yet in possession of the spines.

The *hypogastral* strands consist of diactins, essentially the same as those which make up the parenchymal bundles.

The *dermalia* (Pl. XXII., fig. 6) are quite predominantly

diactins; rough throughout, straight or slightly arched and some with the central annular swelling or knobs. Total length, 286–462  $\mu$  (on an average 380  $\mu$ ); thickness near the middle, 7½–11½  $\mu$ . Rarely the dermalia are stauractins or tauactins; even pentactins and hexactins were met with amongst them during my studies, though in quite a limited number of instances.

I regard it important to mention that up to certain early stages in the post-larval growth of the sponge, the dermalia may be predominantly stauractins, not diactins as in all the larger individuals. Thus, in the little specimen of Pl. XXII., fig. 3, as also in the still smaller one of only 3 mm. diameter, I find stauractins more numerously represented among the dermalia than diactins; whereas, in the specimen of fig. 4, same plate, the two forms of dermalia occur already in the inverse proportion. This change in the predominant form of dermalia during the ontogeny might well be regarded as the repetition of that which had taken place during the phylogeny of the species.

The *gastralia* (Pl. XXII., fig. 13) are almost all hexactins with rough, tapering and pointed rays. Exceptionally forms with a less number of rays and even diactins may occur as the gastralia. The hexactins have distal and paratangential rays 120–220  $\mu$  in length and 12–13½  $\mu$  in thickness at base; the free proximal ray may be twice as long as any other ray in the same spicule and the microtubercles on it may be slightly more strongly developed than those on the others. However, there not infrequently occur such hexactins as have the proximal ray in no way specially distinguished from the others. With their paratangentials the hexactins form a continuous and regularly quadrate-meshed lace-work. The sides of the meshes, 132–242  $\mu$  long, are composed

usually of two rays, but occasionally of three, belonging to as many different spicules and running side by side.

No special *canalaria* are found.

The *oxyhexasters* occur in abundance in all parts of the sponge-wall. In a few instances I have seen them even outside of the dermal layer, and frequently they are borne, together with some discotasters, on the free proximal rays of gastralia. They are mostly normally developed, the terminals being in general slender, minutely rough and nearly straight or slightly wavy. Diameter, 106–136  $\mu$ . The oxyhexasters in the periphery of the wall are somewhat differently characterized from those in the deep parts. The former (Pl. XXII., figs. 7 and 8; also Pl. XXIII., fig. 19) are on the whole slightly larger; their principals are of a perceptible length; and there occur usually 3, sometimes 4, terminals to a principal. In the latter (figs. 14 and 15) the principals have almost disappeared; the terminals are somewhat stronger but less in number, there being generally 2 or rarely 3 of them to a principal. Occasionally the deeply situated oxyhexasters are hemihexactinose and only rarely hexactinose; moreover, their terminals may sometimes be provided at base with some distinctly barb-like microtubercles,—all of which seems never to be the case with the peripheral oxyhexasters. In a certain specimen I have found the terminals in some of the subgastral oxyhexasters supplied with basal barbs about as prominently developed as in *R. mollis*, but in any case this seems to be a character varying much according to individuals as well as within the same individual.

In the smallest specimen I have had (3 mm. in size), oxyhexasters were already numerous present, but all these agreed in

appearance with those occurring in the peripheral parts of the larger specimens, though the terminals numbered usually two to each principal.

The *discoctasters* (Pl. XXII., figs. 9 and 10) are met with in fair abundance in all parts of the wall, though much less numerous than the oxyhexasters. They occur most abundantly in the endosome, in which they may nearly equal the number of the meshes in the gastral lacework; on the other hand, they are found but rarely, if at all, in the ectosome. Of all the Acanthascinae known to me from the Sagami Sea, this species has the smallest discoctasters. Diameter, 76–110  $\mu$  (on an average 94  $\mu$ ). Thus, they are in general smaller than the oxyhexasters. The central node exhibits the six hump-like tubercles more or less prominently developed. The principal is about one-fourth, or more commonly somewhat less than one-fourth, of the length of the entire ray; it is longitudinally ribbed and uneven in contour, being thicker in some parts than in others. The slender terminals number 6–12 to each tuft; they are arranged not in a circle but in a solid bundle. The tuft widely expands distally since the terminals are bent outwards. A tuft measuring  $7\frac{1}{2}$   $\mu$  across at base may be 30  $\mu$  wide at the outer end. The terminal discs are minute and pinhead-like. Sometimes they may show 7 or 8 recurved marginal teeth when examined under a very high power of the microscope.

Now and then there occur discoctasters in which some primary terminals stand out free from the central node, without combining with any of the eight secondary principals.

Both in size and shape the discoctasters of the species seem to most closely resemble the same of *R. tener* F. E. SCH. Their

appearance is so very characteristic that they constitute a highly important differential point in the identification of the present species.

The *microdiscohexasters* (Pl. XXII., fig. 11) are sparsely present. I have met with them mostly in preparations of the ectosome, but they are not altogether wanting in those of the endosome. Diameter 20-25  $\mu$ . The figure I have given will suffice to give a good idea of their appearance.

In the smallest specimen frequently referred to, I have failed to discover a single microdiscohexaster, although the entire body was made into preparations and subjected to examination.

The *basidictyonal* plate was found to be represented for the most part by the usual thin and small meshed limiting layer (Pl. XXII., fig. 17). Here and there in the sparsely microtubercled beams are seen spicular axial canals in the form of plane crosses. At certain places in the layer the beams are developed, though irregularly, in all the three dimensions; thus, bringing about in the parts a dictyonal framework of some massiveness. Probably hexactins, and possibly pentactins also, participate in the formation of such parts. I have omitted to determine the disposition of the axial canals contained in those parts.

### Soft Parts.

Unsatisfactory as is my knowledge concerning the histology of the species, I may put down some points from notes taken long ago. I beg to mention here that Plate XXIII., illustrative

of the soft parts, had been prepared and printed before I found better material for the study in *Euplectella marshalli* (Contrib. I).

An idea of the arrangement of the soft parts may be obtained from Pl. XXIII., figs. 22–24, comments upon which I consider unnecessary beyond the explanations attached to them.

The chambers measure  $88\mu$  in average diameter. In favorably situated parts of their small-meshed reticular wall, I have seen, though faintly, choanocyte-nuclei, generally one to each of the nodes, as shown in fig. 20.

The three round or oval bodies in the lower part of the figure just referred to are without doubt archæocytes, though at the time of drawing them I was under the impression that they were merely nuclei of a special sort. Small groups of the same cells are also seen on the chamber-wall in fig. 19. Occasionally they were observed forming compact masses of a quite large but varying size.

The trabecular cobweb is very extensively developed. Nuclei,  $2-2\frac{1}{2}\mu$  in diameter; usually with several nucleoli-like granules within. The trabeculae, generally very thin and filament-like, are frequently expanded into films (fig. 19), especially on the dermal and gastral limiting surfaces (fig. 18). The film-like parts may appear as if containing irregularly branched and often ill-defined fibers or streaks of condensed protoplasm; this is evidently due simply to irregularities in the thickness, or on the surface, of the film as enunciated on pp. 220–201.

The trabeculae of the gastral surface are pushed out, so to say, by each and every proximal ray of gastralria, so as to form a little cone around the latter (fig. 24). The cone may well be compared to a tent, but it must not be accepted that it invariably exhibits externally a membranous limiting surface. More frequently it is



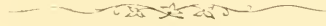
made up of a cobweb of filamentous trabeculae internally as well as in the most superficial situation, similar to the trabecular cones on the dermal surface of *Euplectella marshalli* (Contrib. I., p. 123). Sometimes the trabecular substance may extend as a thin film vertically between adjacent proximal rays of gastralia in a sail-like manner; at other times I have seen it in the form of thin isolated threads running straight from one cone to another or directly between the terminal parts of the rays, each of which basally supported a cone. Such being the real circumstances, the term gastral membrane, unless used with certain explicit reservations, would be apt to lead one into misconceptions.

Thesocytes occur in abundance. I have seen them mostly in the dermal layer and on trabeculae of the subdermal space. Numbers of them may be recognized in figs. 18 and 19 as spherical or ovoid and often conglomerate-like bodies which are stained as well as trabecular nuclei but are much larger. Several are shown much more highly magnified in fig. 21. The cells are of various sizes, from  $4\mu$  up to  $15\mu$  in diameter. The small nucleus is generally seen pressed against the cell-surface, where there probably always exists a delicate enveloping membrane. In the smaller of the cells the contents may sometimes appear to be simply finely granular or homogeneous; otherwise they are seen to contain, or rather to consist of, one or more fat-like spheres of the same microchemical character as the thesocyotal contents of other Hexactinellids. Of the larger thesocytes the majority are represented by compact conglomerate-like groups of the same spheres, showing the appressed nucleus at some part of the periphery. The not very numerous spheres in one such cell are comparatively large and may give it a rosette-like appearance. Thesocytes of the above description I consider to be such as have attained full

development. Certain other thesoocytes of the larger size show irregularly and rather coarsely granular contents, the granulation often being considerably rarified or even entirely obliterated in the peripheral parts. At times the cell-outline is irregular, apparently as the result of shrinkage. Such thesoocytes may be regarded as those in which the contents are undergoing, or have undergone, disintegration preparatory to becoming consumed.

In the present species I have observed a number of oxyhexasters which apparently were not yet fully developed, or had but recently attained full size; at all events they seemed to preserve undisturbed their original relation with the surrounding soft tissues. Reference has already been made in Contribution I., p. 199, to the developing oxyhexaster and the scleroblasts. In this connection I can add nothing of much importance to what I then said; but attention may be called to the three oxyhexasters included in fig. 19. The smallest depicted is about the smallest and youngest I have met with; the fact that the terminals appear to be stained throughout their length indicates the presence of a protoplasmic envelope. The two others may be considered to be of nearly or quite mature development. In all the three oxyhexasters the central parts are enveloped in a nucleated protoplasmic mass running out in the periphery into filamentous trabeculae. The mass itself may indistinctly show a cobweb-like structure and I am inclined to regard it as for the most part nothing else than the trabecular substance. Accordingly, some of the nuclei contained in the mass are probably simply trabecular nuclei, and the rest, scleroblast-nuclei which should be present. It is difficult to discriminate between the two sorts of nuclei; however, I believe that at least those lying immediately around the central node of the

spicules may safely be taken for the scleroblast-nuclei. The nuclei in question occur in this position constantly in all such spicules as are apparently still growing and also for some time after these have attained full dimensions. As viewed in an equatorial optical section of the spicule the said nuclei are seen to be four in number, one situated in each of the four angles formed by the short principals. In certain cases these particular nuclei were found to be somewhat larger than others lying close beside them. For the present I can definitely say nothing more about the matter.



## DIAGNOSES OF THE SPECIES TREATED OF IN THIS CONTRIBUTION.

### Genus LANUGINELLA O. SCHM.

*L. pupa* O. SCHM.—Small, spherical or ovoid, firmly attached at base; with a small, smooth-edged osculum leading into a nearly tubular gastral cavity. External surface smooth or covered with a veil formed of small proctal pentactins. Apertures of excurrent canals not covered by gastral layer. Dermalia, rough stauractins. Gastralia, regular oxyhexactins. Hexasters consist of discohexaster and strobiloplumicome. Discohexaster, varying in size but under 100  $\mu$  dia.; spherical; each short

principal generally with 2-4, rough, moderately strong terminals; marginal prongs of terminal disc, distinctly developed. Strobiloplumicome, 34-76  $\mu$  in dia.

Genus **SCYPHIDIUM** F. E. SCH.

(Diagnosis on p. 20).

*S. longispina* (Ij.).—Saccular, moderately thick-walled, somewhat like a pear in shape but smaller, with an osculum at the upper rounded end; firmly attached by the contracted base. External surface with low conuli, from which there arise long and rather strong, diactinic prostalia. In association with these may occur a few small and inconspicuous pentactinic prostalia, with paratangentials which are smooth or shagreen-like and either regularly cruciate or paratropal. Dermalia, predominantly stauractins with spinose rays. Gastralial, similarly rayed hexactins of a larger size. Oxyhexaster, 88-104  $\mu$  dia., frequently hemihexactinose and hexactinose in the deeper part of the choanosome. Discohexaster, 90-130  $\mu$  dia., with slender terminals. Microdiscohexaster of the typical shape, 23-25  $\mu$  dia.

*S. namiyei* (Ij.).—Saccular, laterally compressed, moderately thick-walled, with one or more secondarily formed oscula (or buds) besides the main osculum, firmly attached by rather broad base. Short, fine prostal needles present in insignificant numbers near the oscular margin; for the rest, the surface is tolerably smooth. Dermalia, stauractins and pentactins with spinose and rather strong rays. Gastralial, similar hexactins and pentactins. Oxyhexaster, 53-76  $\mu$  dia.; only occasionally hemihexactinose.

Discohexaster, up to  $100\ \mu$  in dia.; leading down gradationally to microdiscohexasters of  $35\ \mu$  dia., which are of much the same appearance as the larger discohexaster; terminals slender, with disc composed of distinct prongs.

Genus **VITROLLULA** LJ.

(See p. 37).

*V. fertilis* LJ.—Small, spindle-like or pouch-like; may be laterally compressed; firmly attached at base; with small, simple-edged osculum at the upper end, leading into deep gastral cavity. External surface smooth; internal surface without a gastral layer over the apertures of excurrent canals. Parenchymalia consist of slender diactins and of moderately large hexactins, the latter being not uncommon. Dermalia, rough stauractins; supported by pentaactinic hypodermalia. Gastralia, hexactins and pentaactins; sparsely present. Hexasters of two kinds: Oxyhexaster,  $114$ – $140\ \mu$  in diameter; each short principal with rather numerous, slender, rough terminals; never hexactinose or hemihexactinose. Microdiscohexaster,  $26$ – $30\ \mu$  in diameter, spherical; each principal having numerous fine terminals.

Genus **CRATEROMORPHA** J. E. GRAY.

(Diagnosis on p. 55).

*C. meyeri* J. E. GRAY.—Sponge-body smooth on the outside, the entire sponge being exquisitely wine-glass- or tulip-like. Parenchymalia mainly diactins, with isolated oxyhexactins. Among the pentaactinic hypodermalia, diactins may occasionally occur.

Dermalia, rough pentactins; sometimes stauractins. Microdiscohexaster, spherical; under  $50\ \mu$  dia.

*C. meyeri tuberosa* IJ.—Sponge-body with a number of variously sized, irregularly rounded, tubercle-like prominences on the outside. Spiculation as in the typical *C. meyeri*. Diactins may have a large part in the formation of hypodermal beams.

*C. meyeri rugosa* IJ.—Sponge-body with quite uneven surface, due to numerous wrinkle-like ridges and irregular prominences on the outside. Spiculation as in *C. meyeri tuberosa*, but the parenchymalia lacking in hexactinic elements.

*C. pachyactina* IJ.—Sponge-body shaped somewhat as in *C. meyeri rugosa*; of rather compact texture; with small and scanty incurrent canals. Parenchymalia exclusively diactins, of which the principalia are comparatively large and strong. Hypodermal oxypentactins with strikingly strong rays, which may be  $\frac{1}{2}$  mm. thick at base with a length of  $2\frac{1}{2}$  mm. Dermalia, rough pentactins. Hexasters as in *C. meyeri*.

*C. corrugata* IJ.—Sponge-body of corrugated appearance, due to pit-like or irregular groove-like depressions of the external surface. Many of the pit-like depressions lead into a system of anastomosing intercanals: some of these, extending quite through the sponge at the junction of body with stalk, may give to the latter the appearance of being branched at its upper end. Parenchymalia of diactins only, most of which are thin and small. Hypodermalia, pentactins with occasional diactins. Der-



malia, rough stauractins and pentaetins, the former predominating. Hexasters, essentially as in *C. meyeri*.

### Genus **HYALASCUS** IJ.

(Diagnosis on p. 87).

*H. sagamiensis* IJ.—Body comparatively thin-walled, out-bulged in the middle, with flaring oscular rim. Incurrent and excurrent canalar apertures under 2 mm. diameter. Gastral cavity lined with continuous gastral layer. Discohexaster in one spherical form of 80–90  $\mu$  diameter; each principal bearing usually 3 slender terminals.

*H. similis* IJ.—Quite like the foregoing species; but the discohexaster proper to that species is here exceedingly rare, while the commonest discohexaster is a smaller and not spherical form of 46–50  $\mu$  diameter in which 12 or more delicate terminals to each principal form a separate, expanding and perianth-like tuft.

*H. giganteus* IJ.—Thick-walled: with wide canals and canalar apertures, giving a cavernous appearance to the wall. The incurrent canals form an extensively intercommunicating system. Gastral surface, as also the wall of the larger excurrent canals, is lined by an irregularly meshed endosomal lattice, with no continuous covering layer of gastralia over the meshes. Discohexaster in one spherical form of 30–38  $\mu$  diameter, with 10 or less terminals to each principal.

Genus **AULOSACCUS** IJ.

(Diagnosis on p. 167).

*A. schultzei* IJ.—Thick-walled, vase-like; without conuli or prostal needles on the outside. Gastral surface covered with a sieve-like endosomal lattice, in which the gastralial do not form a continuous layer over the meshes. Dermalia, rough pentactins or predominantly pentactins. Macrodiscohexaster, very large measuring nearly 1 mm. in diameter; sun-like, the six principals being fused into a spherical mass 46–49  $\mu$  in diameter. Microdiscohexaster, 26–38  $\mu$  in diameter.

*A. mitsukurii* IJ.—Moderately thick-walled, tubular; external surface with cones, from the apex of which project needle-like prostalia either singly or in a small tuft. Gastral surface lined by a continuous gastral layer. Dermalia, predominantly stauractins, the entire surface of which is covered with rather strong prickles. Macrodiscohexaster, 80–120  $\mu$  in diameter; the short knob-like principals being separate. Microdiscohexaster, 20–23  $\mu$  in diameter.

Genus **ACANTHASCUS** F. E. SCH.

(Diagnosis on p. 139).

*A. cactus* F. E. SCH.—Cup-like, vase-like or funnel-shaped; sometimes bearing a secondary person or persons. Dermalia, predominantly stauractins, occasionally pentactins. Gastralial, mostly pentactins and sometimes stauractins; not forming a continuous lattice-work. Oxyhexaster, 90–152  $\mu$  dia.; often hemihexactinose and not seldom hexactinose. Peripheral disc-

octaster, 106–137  $\mu$  dia.; more deeply situated discoctaster, generally 200–260  $\mu$  dia.; secondary principal in length shorter than, or about equal to, the terminals. Microdiscohexaster, 15–23  $\mu$  dia.

*A. alani* LJ.—Ovoid in shape; thick-walled. (Prostal diactins present?). Dermalia, almost exclusively pentactins. Gastralia, hexactins; not forming a continuous lacework over excurrent canalar apertures. Oxyhexaster, 144–190  $\mu$  dia.; generally normal, with 2–4 terminals to each principal; seldom hemihexactinose. Discoctaster, 136–220  $\mu$  dia.; secondary principal about equal to, or longer than, the terminals. Microdiscohexaster, 30–35  $\mu$  dia.

#### Genus **STAUROCALYPTUS** LJ.

(Diagnosis on p. 162.)

*S. ræperi* (F. E. SCH.).—Cup-like, with short stalk-like base. With peculiar pit-like subdermal cavities whence arise narrow incurrent canals. Excurrent canalar apertures, relatively very wide (up to 8 mm. dia.); all freely open. All spicules with remarkably slender rays. Pentactinic hypodermalia, small; with paratangentials under 2 mm. in length. Principal parenchymalia under 35  $\mu$  in thickness. Dermalia, slightly rough pentactins; not infrequently stauractins. Gastralia, similar hexactins. Oxyhexaster, 88–130  $\mu$  dia.; some hexactinose. Discoctaster, 128–180  $\mu$  dia. Microdiscohexaster, 22–24  $\mu$  or more in dia.

*S. dowlingi* (L. M. LAMBE).—Broadly sacciform, somewhat outbulged on one side and narrowed at base. Canalar apertures

small; those on the gastral surface freely open. Both diactinic and pentactinic prosetalia present over the entire body; the latter are small with granular-surfaced paratangentials about 2.2 mm. long. Principal parenchymalia, fine (less than  $41\ \mu$  in breadth). Dermalia, rough pentaactins; exceptionally diactins. Gastralia, similar but smaller hexactins, with rays of  $80\text{--}100\ \mu$  length. Oxyhexaster,  $100\text{--}120\ \mu$  dia.; both hemihexactinose and hexactinose forms numerous. Discoetaster,  $228\text{--}320\ \mu$  dia. Microdiscohexaster,  $20\ \mu$  dia.

*S. tubulosus* IJ.—Similar to *S. dowlingi* in general characters and in spiculation. Body, tubular. Gastral surface with freely open canalar apertures; hairy on account of the projecting ends of fine parenchymalia. Paratangentials of pentaactinic prosetalia, generally under 2 mm. in length; rarely 4 mm.; acquiring a rough surface due to nearly vertical, fine and sharply pointed microspines. Principal parenchymalia may be 12 mm. long and  $130\ \mu$  broad. Dermalia, rough pentaactins but frequently stauractins and rarely hexactins. Gastralia, similar hexactins, with rays  $130\text{--}200\ \mu$  in length. Oxyhexaster,  $75\text{--}115\ \mu$  dia.; very rarely hexactinose. Discoetaster,  $130\text{--}213\ \mu$  dia. Microdiscohexaster,  $19\ \mu$  dia.

*S. affinis* IJ.—Similar to *S. dowlingi* in general characters and in spiculation. Body, tubular or vase-like. Canalar apertures on the gastral surface, some freely open while others are covered with a small-meshed endosomal lattice, developed in irregular patches and in which the gastralia do not form a continuous lacework. Pentaactinic prosetalia, large; with smooth or granular paratangentials  $5\text{--}12$  mm. in length. Principal parenchymalia,

long and thick (some over 25 mm. long and over 500  $\mu$  thick). Dermalia, rough pentactins; rarely stauractins. Gastralialia, similar hexactins with rays 140–175 mm. long or even longer. Oxyhexaster, 115–160  $\mu$  dia.; hexactinose forms quite numerous. Discoctaster, 120–400  $\mu$  dia. Microdiscohexaster, 19–20  $\mu$  dia.

*S. entacanthus* L.—Similar to *S. dowlingi* in general characters and in spiculation. Body, vase-like (?). Gastral surface, entirely covered with a small-meshed endosomal lattice in which the gastralialia do not form a continuous lacework, but which extends over all the excurrent canalar apertures. This surface is beset with rather coarse projecting needles which render it conspicuously spiny. Diactinic prostalia not found on the lateral surface. Pentactinic prostalia with smooth or granular paratangentials reaching up to 4 mm. or more in length. Principal parenchymalia may be 250  $\mu$  thick. Dermalia, rough pentactins; rarely stauractins and diactins. Gastralialia, similar hexactins with rays 95–130  $\mu$  or more in length. Oxyhexaster, 100–132  $\mu$  or more in dia.; hexactinose forms not found (entirely wanting?). Discoctaster, about 150  $\mu$  up to nearly 300  $\mu$  in dia. Microdiscohexaster, not found (wanting?; if present, 19  $\mu$  dia.).

*S. microchetus* L.—Tubular, laterally compressed. Canals very narrow. With inconspicuous veil, formed of pentactins in which the paratangentials are regularly cruciate and measure not more than 14 m.m. in length. Dermalia generally stauractins, exceptionally pentactins; rays beset with rather strongly developed microtubercles. Gastralialia, similar hexactins. Oxyhexasters in the subdermal region, 68–100  $\mu$  dia.; those in deeper parts, 106–136  $\mu$  dia., with stronger rays; occasionally hemihexactinose;

hexactinose forms not found. Discoctaster, 114–128  $\mu$ ; found in subgastral region only. Microdiscohexaster, 23–26  $\mu$  dia.; rare.

*S. glaber* IJ.—Saccular or vase-like; thick-walled; somewhat laterally compressed after attaining a certain size. Small young specimens with fine long prostal needles which seem however to become lost with growth. Pentactinic prostalia, never present; so that old specimens have a quite smooth external surface. The extensive subdermal space and large canals give a cavernous appearance to the delicately textured wall. Dermalia, nearly all stauractins with microtubercles most strongly developed on the outer side of the rays. Gastralia, moderately large oxyhexactins, generally with the free proximal ray longer and more rough than the others. Oxyhexasters, 98–114  $\mu$  in diameter; all normally developed, having 2–4 terminals to a principal. Discocasters may be of an unusually large size; 240–660  $\mu$  in diameter. Microdiscohexasters, 15–22  $\mu$  diameter; not uncommon, but sometimes extremely rare.

*S. heteractinus* IJ.—Laterally compressed, pouch-like, with narrow canals. No prostalia of any kind. Dermalia, predominantly stauractins, occasionally pentactins and tauactins, rarely diactins; with slightly rough rays. Gastralia, similarly rayed but smaller pentactins and stauractins; not forming a continuous lacework. Oxyhexasters, always normally developed; 106–114  $\mu$  in diameter. Discocasters, 110–200  $\mu$  in diameter. Microdiscohexasters, 16–19  $\mu$  in diameter; common in certain parts.

*S. pleorhaphides* IJ.—Thick-walled, pear-shaped, attached by the narrower end. With strong prostal needles and a gossamer-



like layer of proctal pentactins, springing out from the small conuli of the surface. Dermalia, nearly all rough diactins. Gastralia, similar diactins. Oxyhexasters mostly normal or hemihexactinose; rarely hexactinose; with rather strong, rough terminals;  $114\ \mu$  in average diameter. Discoctasters, small;  $100\text{--}200\ \mu$  in diameter. Microdiscohexasters,  $20\ \mu$  in average diameter; sparsely present.

Genus **RHABDOCALYPTUS** F. E. SCH.

(Diagnosis on p. 236).

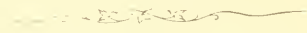
*R. victor* JI.—Vase-like; somewhat laterally compressed, especially at base. Veil and fine proctal needles present in the young stage but later are generally cast off. Dermalia, nearly all rough stauractins. Gastralia, similarly rayed hexactins of a nearly regular shape. Oxyhexasters, with rough terminals:  $180\text{--}280\ \mu$  in dia.; hemihexactinose form, numerous; hexactinose form, not uncommon. Discoctasters,  $180\text{--}240\ \mu$  in dia.; terminals nearly straight. Microdiscohexaster of the usual size and shape in sparse distribution.

*R. mollis* F. E. SCH.—Vase-like or sac-like, laterally compressed; with a strong tendency to form tubular daughter persons along one of the sagittal body-edges. Veil generally cast off. Dermalia, nearly all rough diactins. Gastralia, similarly rayed hexactins of nearly regular shape. Oxyhexasters with terminals more or less distinctly barbed at base; hemihexactinose and hexactinose forms, common;  $102\text{--}160\ \mu$  in dia. Discoctasters,  $130\text{--}176\ \mu$  in dia.; terminals nearly straight or slightly bent

outwards. Microdiscohexasters, present in variable numbers; 22–27  $\mu$  in dia.

*R. unguiculatus* IJ.—Vase-like; entirely covered with a thick gossamer-like veil. Dermalia, nearly all rough diactins. Gastralia, hexactins; similarly rough but with much longer rays, the free proximal ray being especially well developed; the radial axis, 640–850  $\mu$  long. Oxyhexasters, 130–160  $\mu$  in diameter; not infrequently hemihexactinose and only occasionally hexactinose. Discostasters, 143–190  $\mu$  in diameter; principals, 20–25  $\mu$  long; terminal tufts expanded at the outer end; terminal discs with strongest marginal teeth on the side turned away from the axis of the tuft, or toothed only on that side. Microdiscohexasters, sparse; 22–30  $\mu$  in diameter.

*R. capillatus* IJ.—Vase-like or sac-like, more or less laterally compressed; entirely covered with a thick gossamer-like veil. Dermalia, nearly all rough diactins. Gastralia, rough hexactins in which the free proximal ray may be twice as long as any other ray in the same spicule. Oxyhexasters, 106–136  $\mu$  in diameter; occasionally hemihexactinose and rarely hexactinose. Discostaster small, measuring 82–106  $\mu$  in diameter; terminal tuft distinctly outflaring at the outer end. Microdiscohexasters, sparse; 20–25  $\mu$  in diameter.



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**N. B.****A Correction with Regard to the Generic Name *Placosoma*  
applied by me to an Euplectellid.**

In Contribution III., I described a new Euplectellid genus and species under the name of *Placosoma paradictyum*. Now, Professor F. E. SCHULZE, in a letter, has very kindly pointed out to me the fact, which I had entirely overlooked, that the generic name "*Placosoma*" had been pre-occupied, having been employed by TSCHUDI for a reptilian genus in 1847 (Arch. f. Naturgesch., Bd. 13, I., p. 50). I therefore beg to withdraw that generic name as applied by me to the Euplectellid and to substitute for it "*Bolosoma*" ( $\beta\omicron\lambda\omicron\varsigma$ =clump),—a designation, for the suggestion of which I am likewise indebted to Professor SCHULZE. Henceforth, the Euplectellid in question should go by the name of

*Bolosoma paradictyum*.



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I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE I.

*Lanuginella* pupa O. SCHUM.

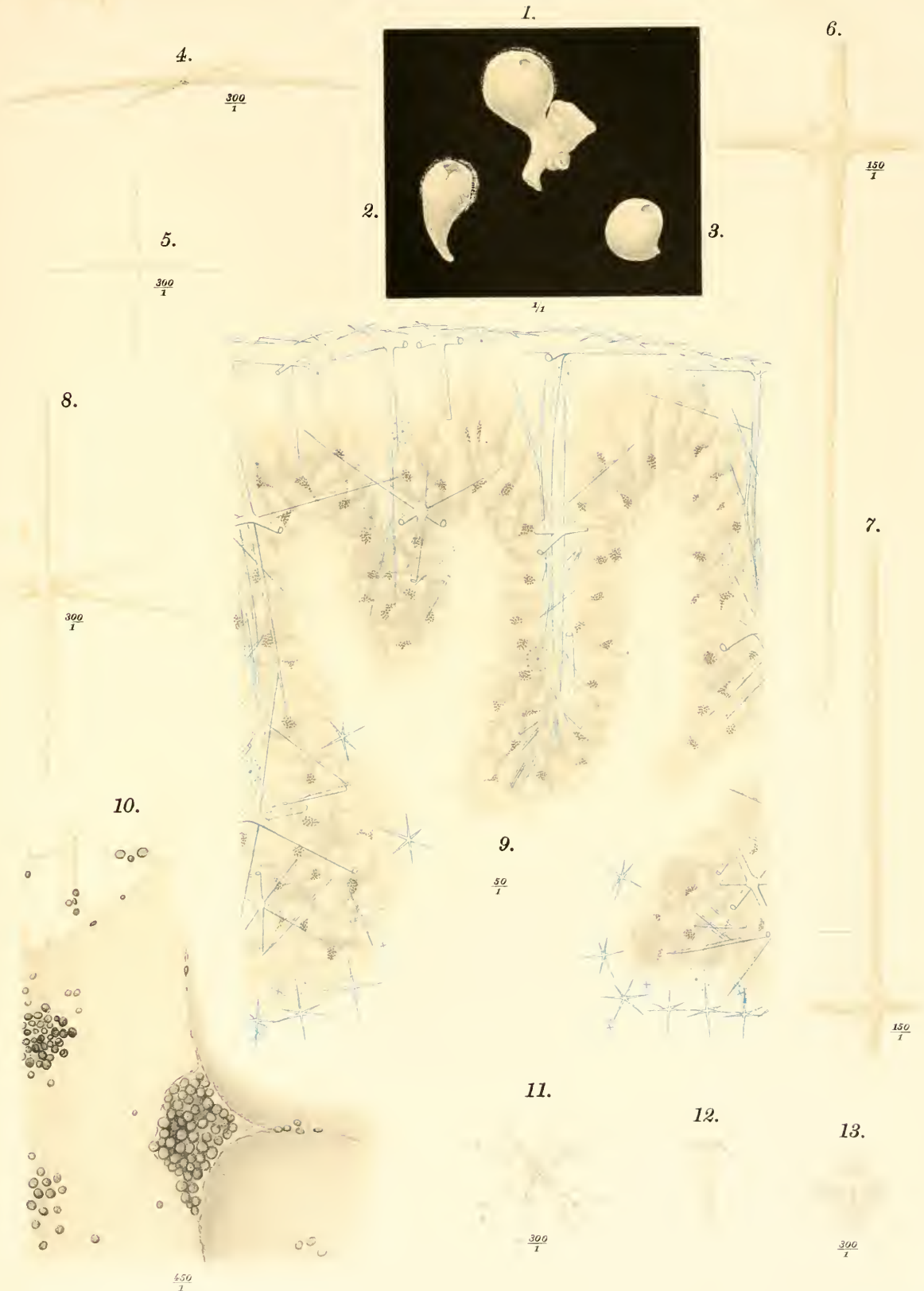
## Plate I.

*Lanuginella pupa* O. SCHM.

P. 3.

- Figs. 1-3. Three specimens in natural size. Fig. 1, attached to a dead coral. Figs. 1 and 2, with veil over the surface.
- Fig. 4. Dermalia in lateral view. 300  $\times$ .
- Fig. 5. Same in an early stage of development. 300  $\times$ .
- Fig. 6. Part of a large hypodermal pentactin as seen from distal side. 150  $\times$ .
- Fig. 7. Part of a prestal pentactin forming the veil; seen from distal side. 150  $\times$ .
- Fig. 8. Gastralia in lateral view. 300  $\times$ .
- Fig. 9. Section of sponge-wall, showing a wide and branched excurrent canal, the chamber-layer with archaeocyte-congeries, etc. Above, the dermal side; below, the gastral side. 50  $\times$ .
- Fig. 10. Parts of the walls of three chambers lying close together. Archaeocytes and membrana reticularis very badly represented. Above, trabeculae arising from chamber-rim. 450  $\times$ .
- Fig. 11. Discohexaster. 300  $\times$ .
- Fig. 12. Outer end of discohexaster terminal. Highly magnified.
- Fig. 13. Plumicome. 300  $\times$ .

(Figs. 4-13 were all taken from the specimen shown in fig. 1 [Sci. Coll. Mus. No. 229]. For more figures relating to the species, see Contribution III, Pl. V.).



*Lanuginella pupa* O. SCHM.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE II.

*Scyphidium longispina* (Ij.).

## Plate II.

*Scyphidium longispina* (L.).

P. 22.

- Fig. 1. The type specimen (Sci. Coll. Mus. No. 222); with two small young individuals attached to the prostalia of the large one. Natural size. All the other figures in this plate, except fig. 15, are taken from the largest individual.
- Fig. 2. Dermalia in lateral view. 300  $\times$ .
- Fig. 3. Part of a pentactinic hypodermalia. 150  $\times$ .
- Fig. 4. Gastralia. 300  $\times$ .
- Fig. 5. Hexactinose oxyhexaster. From a deep part of the wall. 300  $\times$ .
- Fig. 6. Hemihexactinose oxyhexaster. From a deep part of the wall. 300  $\times$ .
- Fig. 7. Discohexaster. 300  $\times$ .
- Fig. 8. Outer end of a discohexaster terminal. About 1000  $\times$ .
- Fig. 9. Microdiscohexaster. 300  $\times$ .
- Fig. 10. Section of wall; part adjoining the outer surface. Above, dermal layer; with a pentactinic prostal and two strong diactinic prostals cut off. About 25  $\times$ .
- Fig. 11. Section of wall; part adjoining the inner surface. Below, gastral layer. About 25  $\times$ .
- Fig. 12. Trabeculae and thesocytes; from a borax-carminé preparation. The nuclei appear as deeply stained dots. The thesocyte product is represented by the large, more or less globular, strongly stained bodies. Smaller, more weakly stained and granular spheres represent probably a stage in the development of the thesocyte product. 450  $\times$ .
- Fig. 13. Chamber-rim; not well preserved. The larger deeply stained dots in groups are probably archæocytes; the weakly stained spheres of granular appearance are likely thesocytes not yet fully grown. Stained with borax-carminé. 450  $\times$ .
- Fig. 14. Chamber-wall. The deeply stained dots are probably partly archæocytes and partly trabecular nuclei. Choanocyte nuclei are scarcely indicated in the figure. Strongly magnified.
- Fig. 15. Peculiar bodies of uncertain nature, consisting of well-stained threads arranged in diverging bunches or in a radial manner. Seen in one of the two young individuals attached to the prostal needles. 300  $\times$ .

3.

2.

1.

7.

5.

4.

6.

8.

9.



10.

12.

14.

13.

15.

11.

25x

25x

*Scyphidium longispina(IJ.).*



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE III.

Vitrollula fertilis Ij.

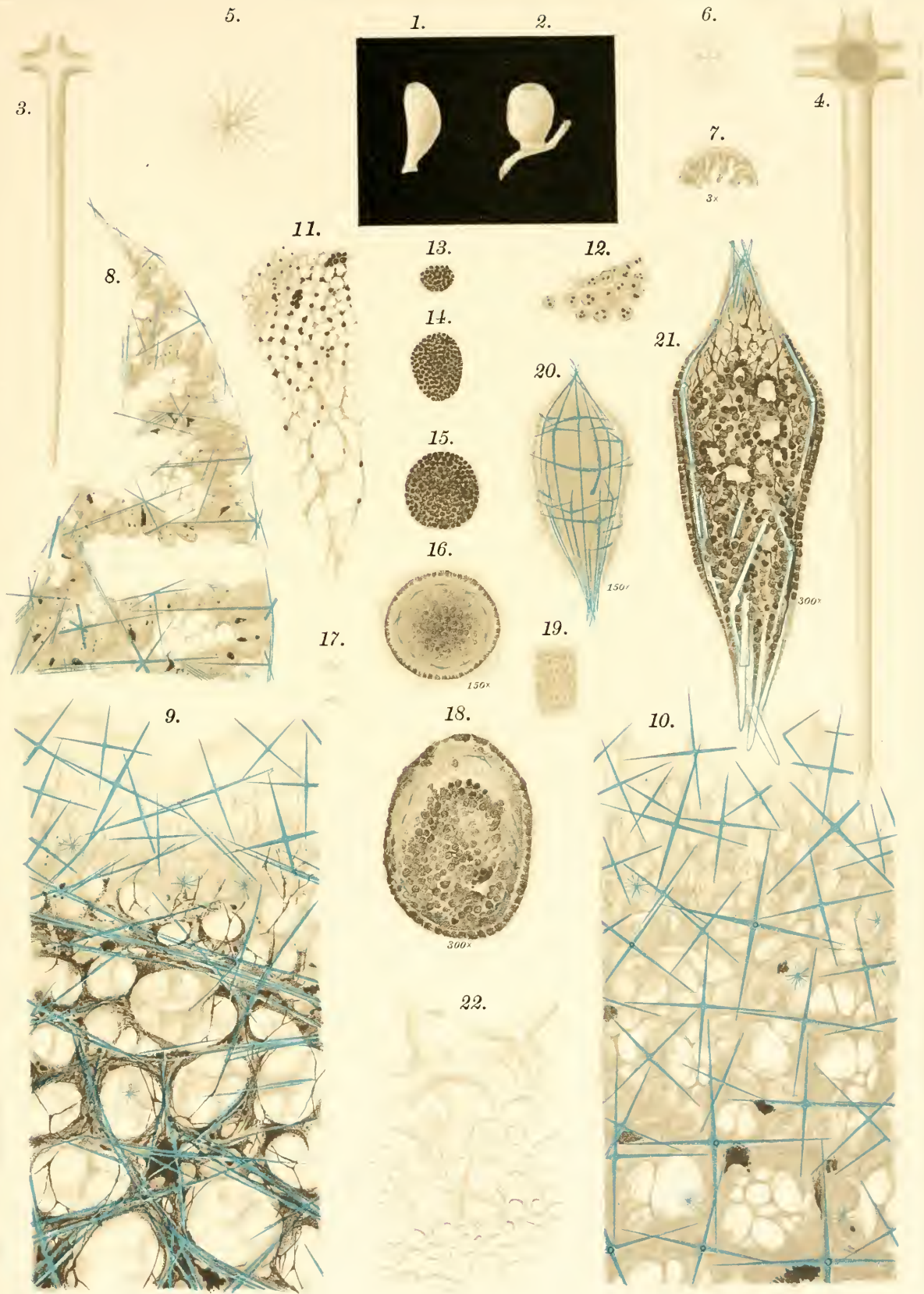
### Plate III.

*Vitrellula fertilis* Is.

P. 38.

- Fig. 1. One of S. C. M. Sp. No. 228, found attached to a dead coral. From Okinósé. Nat. size.
- Fig. 2. S. C. M. Sp. No. 231, attached to a worm-tube. From off Inatori. Nat. size.
- Fig. 3. Part of a moderate-sized stauractinic dermalia. 300  $\times$ .
- Fig. 4. Part of the paratangential cross of a hypodermal pentactin. 300  $\times$ .
- Fig. 5. Oxyhexaster. 300  $\times$ .
- Fig. 6. Microdiscohexaster, the only form of discohexaster present in the species. 300  $\times$ .
- Fig. 7. Part of a stained transverse section through the body of Sp. No. 231. Excurrent canal opening freely into the gastral cavity. 3  $\times$ .
- Fig. 8. Part of a longitudinal section of the same specimen. Above, the oscular margin. About 25  $\times$ .
- Fig. 9. Surface view of the stained wall of S. C. M. Sp. No. 433; above, oscular margin. Seen from the gastral side. About 50  $\times$ .
- Fig. 10. Same, seen from the dermal side. About 50  $\times$ .
- Fig. 11. Showing the gradual transition of *membrana reticularis* (above) into trabeculae (below) near the oscular margin. From a hæmatoxylin preparation. 300  $\times$ .
- Fig. 12. A small group of archæocytes lying on the chamber-wall. From a borax-carminé preparation. 1000  $\times$ .
- Figs. 13-16. Stages in the development of a larva, from sections of Sp. No. 231. Stained with borax-carminé. 150  $\times$ .
- Fig. 17. Stauractinic spicules from the larval stage of fig. 16. The lower figure, in side view. 440  $\times$ .
- Fig. 18. Section of a developing larva, somewhat more advanced than that of fig. 16. Stained with hæmatein-alum. 300  $\times$ .
- Fig. 19. The outer layer of flagellated cells, seen surface on. From the same larva. 300  $\times$ .
- Fig. 20. A fully developed larva in optical section, but with the peripherally situated spicules of one side drawn in. 150  $\times$ .
- Fig. 21. Longitudinal section of a fully developed larva, stained with hæmatein-alum. 300  $\times$ .
- Fig. 22. Basidietyonalia, joined below to the small-meshed attachment plate. 100  $\times$ .







I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

## PLATE IV.

*Crateromorpha meyeri* J. E. GRAY.

*C. meyeri tuberosa* IJ.

*C. meyeri rugosa* IJ.

*C. pachyactina* IJ.

## Plate IV.

Figs. 1-8. Typical *Crateromorpha meyeri* J. E. GRAY. P. 57.

Fig. 1. A specimen of typical *C. meyeri*. (S. C. M. No. 364). Nat. size. Figs. 2-8 were all taken from this specimen.

Figs. 2, 3. Dermalia. 300  $\times$ .

Fig. 4. Microdiscobexaster. 300  $\times$ .

Fig. 5. Oxyhexaster. 300  $\times$ .

Fig. 6. Dermalia and hypodermalia in situ; seen from outside. About 20  $\times$ .

Fig. 7. Section of wall. About 20  $\times$ .

Fig. 8. Basidictyonalia, from middle of stalk. 100  $\times$ .

Fig. 9. *C. meyeri tuberosa* L. P. 66.

Fig. 9. Microdiscobexaster. 300  $\times$ . (This figure might pass for that of the corresponding spicule of *C. meyeri rugosa*).

Figs. 10, 11. *C. meyeri rugosa* L. P. 71.

Fig. 10. Canalar surface of stalk, with canalaria and fused parenchymalia. 50  $\times$ .

Fig. 11. Dermalia and hypodermalia in situ; seen from outside. About 20  $\times$ . (This figure might pass for that of the corresponding skeletal parts of *C. meyeri tuberosa*).

Fig. 12. *C. meyeri*.

Fig. 12. Cross-section of stalk, showing the canals running through it.  $\frac{1}{2}$  nat. size.

Fig. 13. *C. pachyactina* L. P. 74.

Fig. 13. Thick-rayed hypodermal pentactin, together with a few dermalia and comitalia. (From S. C. M. No. 395). 20  $\times$ .

2.

1.

3.

4.

9.

5.

10.

50x

6.

20x

12.

7. 20x

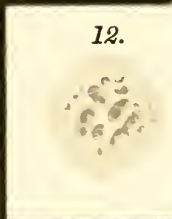
11.

20x

8. 100x

13.

20x



1—8, 12. *Crateromorpha meyeri* (J. E. GRAY) CARTER. 9. *C. meyeri tuberosa* IJ.

10, 11. *C. meyeri rugosa* IJ.

13. *C. pachyactina* IJ.







L. JENNA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE V.

*Crateromorpha meyeri tuberosa* Lj.

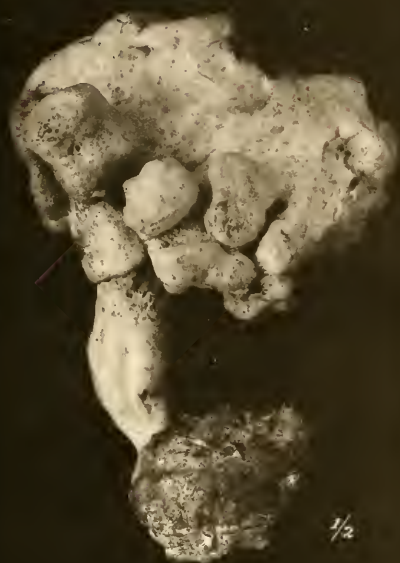
*Crateromorpha meyeri rugosa* Lj.

## Plate V.

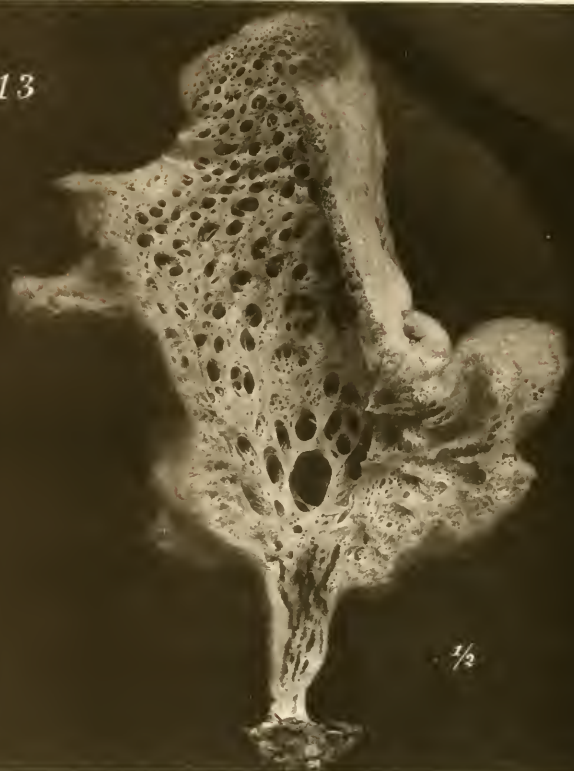
(All figures in half natural size).

- Fig. 12. A specimen of *Crateromorpha meyeri tuberosa* Lj. from Homba. S. C. M. No. 444.
- Fig. 13. Another specimen of same, from Outside Okinose. S. C. M. No. 445. A part of the wall and of the stalk removed.
- Fig. 14. A specimen of *Crateromorpha meyeri rugosa* Lj. from Outside Okinose. S. C. M. No. 366.
- Fig. 15. Another specimen of same, from Homba. S. C. M. No. 360. A part of the wall and of the stalk removed.

12



13



14



15



12, 13. *Crateromorpha meyeri tuberosa* Ij.

14, 15. *C. meyeri rugosa* Ij.



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STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE VI.

*Crateromorpha corrugata* IJ.

*Scyphidium namiyei* (IJ.).

## Plate VI.

*Crateromorpha corrugata* IJ.

P. 78.

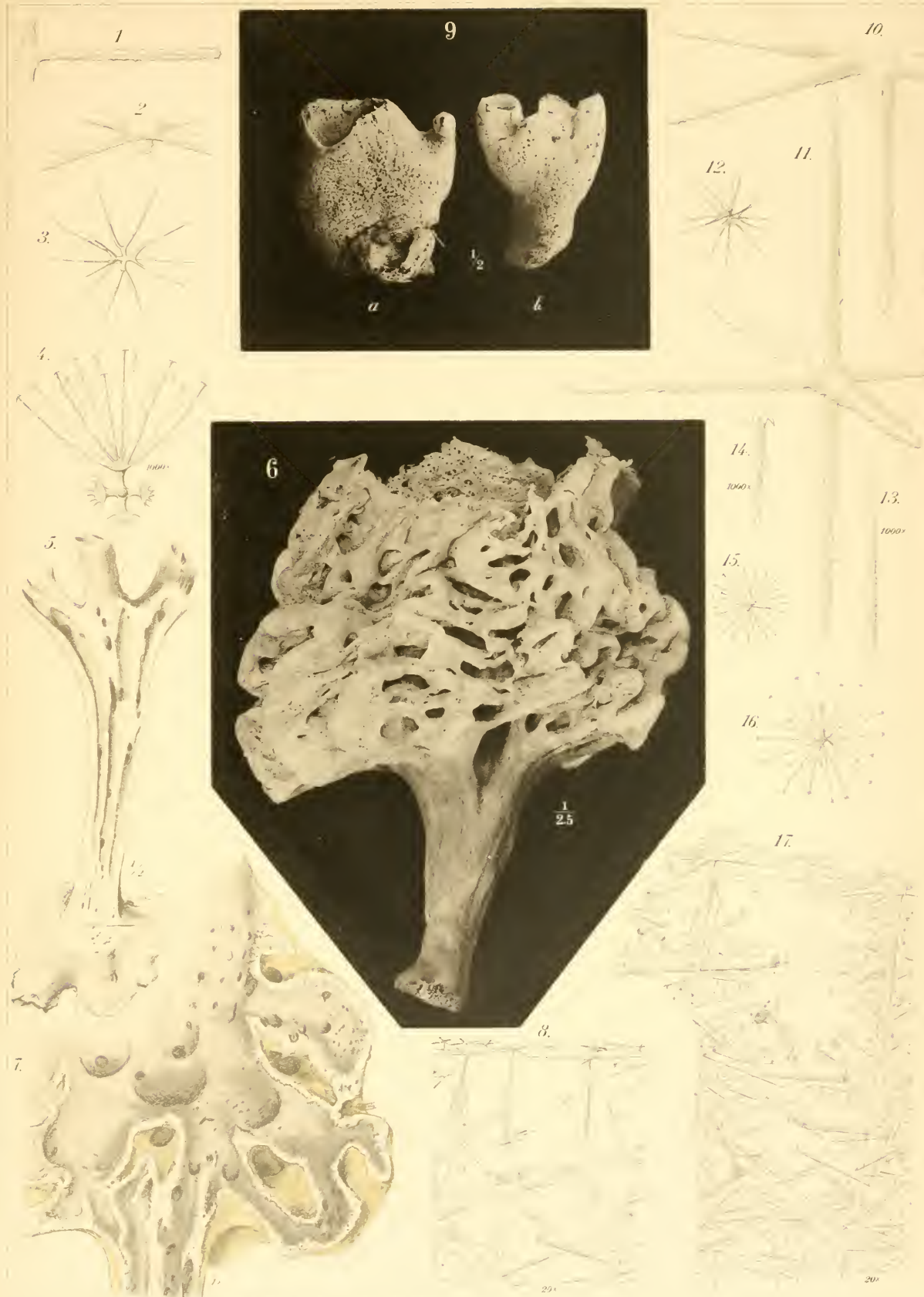
- Figs. 1. & 2. Dermalia drawn in part. 300  $\times$ .  
Fig. 3. Oxyhexaster. 300  $\times$ .  
Fig. 4. Part of a discohexaster. 1000  $\times$ .  
Fig. 5. Stalk and basal disc; the former cut open longitudinally to show the internal canals. Above, the stalk is branched at the junction with the body proper, which is lost.  $\frac{1}{2}$  nat. size.  
Fig. 6. An entire specimen (O. C. No. 108).  $\frac{1}{2.5}$  nat. size.  
Fig. 7. The body of another complete specimen (S. C. M. No. 365) longitudinally bisected. The dermal surface, including that of intercanals, is colored yellow. Nat. size.  
Fig. 8. Spiculation of the body-wall. Above, dermal surface; below, gastral surface. About 20  $\times$ .

Figs. 9-17. *Scyphidium namiyei* (IJ.).

P. 32.

- Figs. 9, *a* & *b*. The two type-specimens (S. C. M. No. 362). About  $\frac{1}{2}$  nat. size.  
Fig. 10. Pentactinic dermalia. 300  $\times$ .  
Fig. 11. Gastralia. 300  $\times$ .  
Fig. 12. Oxyhexaster. 300  $\times$ .  
Fig. 13. A terminal from the same. 1000  $\times$ .  
Fig. 14. Outer end of discohexaster terminal. 1000  $\times$ .  
Fig. 15. Microdiscohexaster. 300  $\times$ .  
Fig. 16. Discohexaster. 300  $\times$ .  
Fig. 17. Spiculation of the wall. Above, dermal layer; below, gastral layer. About 20  $\times$ .





1—8. *Crateromorpha corrugata* Ij.  
9—17. *Scyphidium namiyei* Ij.

Painted by Kunitaka Kanda, Tokyo, Japan.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE VII.

*Hyalascus sagamiensis* IJ.

## Plate VII.

*Hyalascus sagamiensis* II.

P. 88.

Fig. 1. The type-specimen, which is probably to be found preserved at Amherst College (Prof. B. K. EMERSON), Mass., U. S. A. About  $\frac{1}{3}$  nat. size.

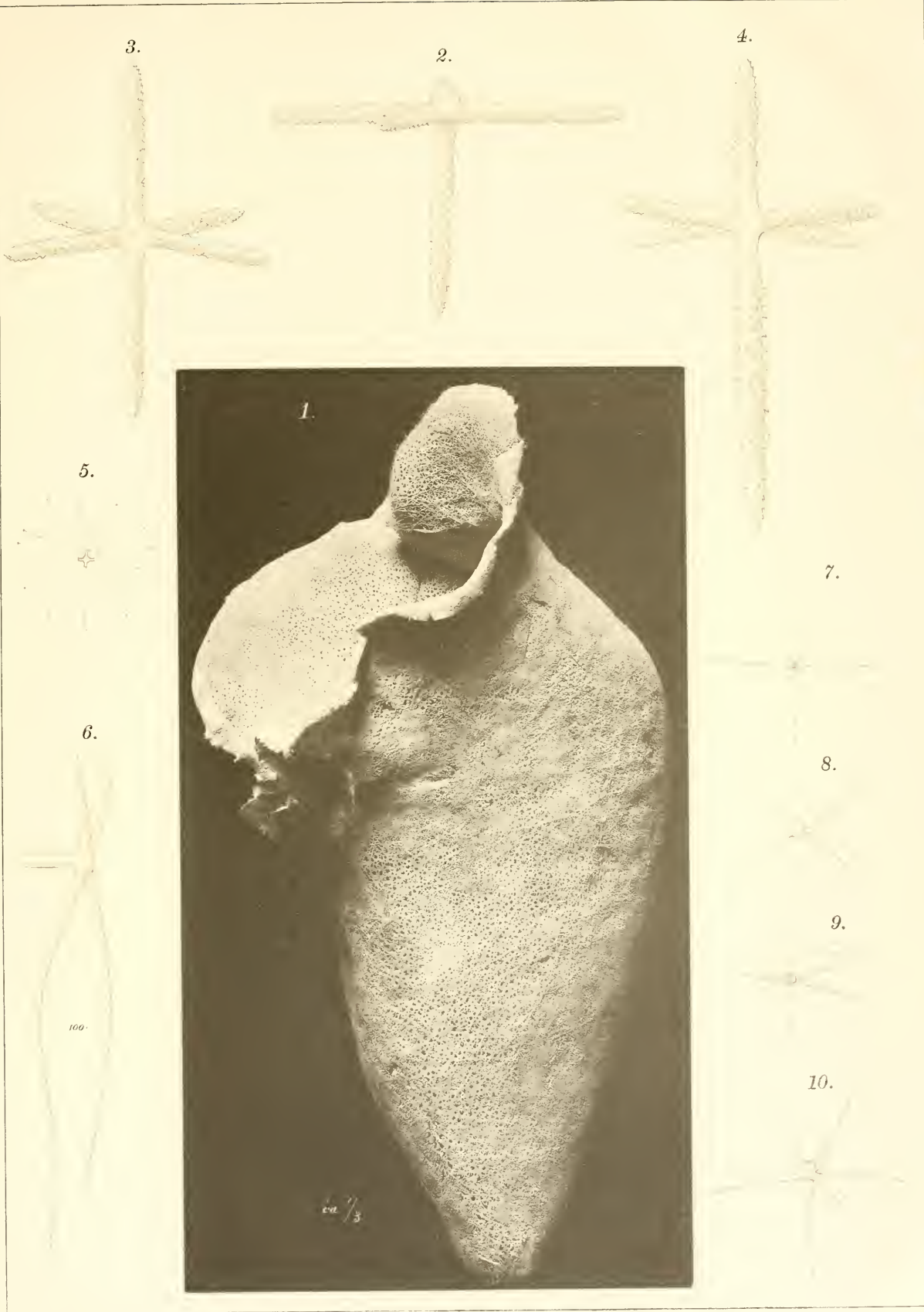
Figs. 2, 3. Dermalia. 300  $\times$ . (Fig. 3 is not good, the rays being drawn relatively too short or too thick).

Fig. 4. Gastralia. 300  $\times$ . (This figure is again not good, the rays being drawn relatively too short or too thick).

Fig. 5. Discohexaster. 300  $\times$ .

Fig. 6. Hypodermal oxypentactin. 100  $\times$ .

Figs. 7-10. Oxyhexasters. 300  $\times$ . Fig. 7, a hexactinose form. Fig. 8, an exceptional degenerate form in which the rays are reduced to only four in number. Figs. 9 and 10, hemihexactinose forms.



*Hyalascus sagamiensis* Ij.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE VIII.

*Hyalascus sagamiensis* Ij.

*H. giganteus* Ij.

*Staurocalyptus microchetus* Ij.

*Aulosaccus schulzei* Ij.

## Plate VIII.

Figs. 1-12. *Hydascus sayamiensis* IJ. P. 88.

Fig. 1. Spicules on and near the dermal surface in oblique view; Some dermalia, hypodermalia and parenchymalia.  $50\times$ .

Fig. 2. Gastral layer (below) and some spicules (parenchymalia and oxyhexasters) directly beneath it; from a section.  $50\times$ .

Figs. 3-16. *Hydascus giganteus* IJ. P. 100.

Fig. 3. A small portion of the dermal surface, much abraded, of the type specimen preserved in the British Museum. Nat. size.

Fig. 4. A small portion of the gastral surface of same. Nat. size.

Fig. 5. Spicules on and near the dermal surface in oblique view: some dermalia, a hypodermal pentactin and some parenchymalia.  $50\times$ .

Fig. 6. Gastralia and hypogastral beams in surface view.  $50\times$ .

Fig. 7. Gastral hexactin.  $300\times$ .

Fig. 8, 9. Dermalia.  $300\times$ .

Fig. 10. Discohexaster.  $300\times$ .

Fig. 11. Portion of the same, more highly magnified.

Figs. 12-16. Various forms of oxyhexaster.  $300\times$ .

Figs. 17-25. *Staurocalyptus microchelus* IJ. P. 202.

Fig. 17. The type specimen (S. C. M. No. 450). Nat. size.

Fig. 18. Dermalia.  $300\times$ .

Fig. 19. Gastralia.  $300\times$ .

Fig. 20. Oxyhexaster from a deep part of the wall.  $300\times$ .

Fig. 21. Oxyhexaster from periphery of the wall.  $300\times$ .

Fig. 22. Microdiscohexaster.  $300\times$ .

Fig. 23. Discoctaster.  $300\times$ .

Fig. 24. Dermal layer in oblique view and underlying spicules, some hypodermal pentactins protruded as prostalia.  $50\times$ .

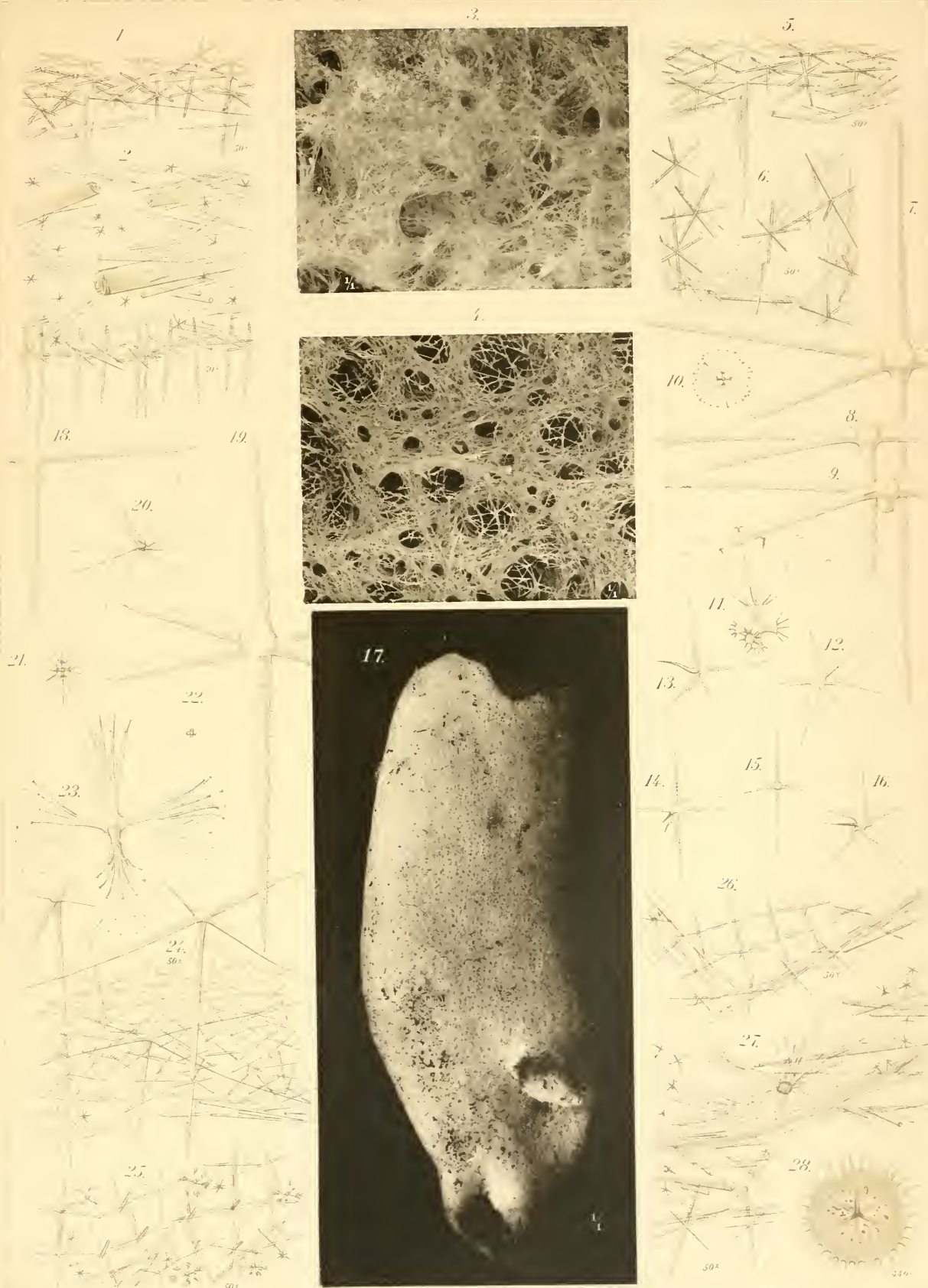
Fig. 25. Gastral layer in surface view; some discoctasters and oxyhexasters in situ.  $50\times$ .

Figs. 26-28. *Autosaccus schulzei* IJ. P. 110.

Fig. 26. Dermal layer and hypodermal beams (ectosomal skeleton) in surface view.  $50\times$ .

Fig. 27. Two gastralia (below) and adjoining spicules in situ. Amongst the latter, a macrodiscohexaster.  $50\times$ .

Fig. 28. Central sphere of macrodiscohexaster, examined in glycerine, showing the axial cross.  $440\times$ .



1—2. *Hyalascus sagamiensis* Ij.  
17—25. *Staurocalyptus microchetus* Ij.

3—16. *H. giganteus* Ij.  
26—28. *Aulosaccus schulzei* Ij.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE IX.

*Aulosaccus schulzei* Ij.

## Plate IX.

*Autosuccus schulzei* B.

P. 110.

Fig. 1. The type specimen, now preserved probably at Amherst College (Prof. B. K. EMERSON), Mass., U. S. A. About  $\frac{1}{3}$  natural size.

Figs. 2-7. Oxyhexasters. 300  $\times$ . Fig. 2 is hexactinose, the commonest form. Fig. 6 is hemihexactinose. All the rest are degenerate forms, in which one or more principals, together with their terminals, have disappeared.

Fig. 8. Macrodiscohexaster. 150  $\times$ .

Fig. 9. Outer end of a terminal belonging to a macrodiscohexaster. 450  $\times$ .

Fig. 10. Microdiscohexaster. 300  $\times$ .

Fig. 11. Gastralia. 300  $\times$ .

Fig. 12. Dermalia. Not quite 300  $\times$ .

Figs. 13, 14. Scopulae of extrinsic origin, found in the type specimen. 300  $\times$ . The figures were inadvertently introduced into the plate.





*Aulosaccus schulzei* Ij.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE X.

*Aulosaccus mitsukurii* Ij.

*Acanthascus alani* Ij.

## Plate X.

Figs. 1-15. *Aulosaccus mitsukurii* Ir.

P. 117.

Fig. 1. The type-specimen in the Sci. Coll. Museum (No. 427), attached to *Isis*.  $\frac{1}{2}$  nat. size. (Figs. 2-15 were all taken from this specimen).

Figs. 2, 3. Macrodiscohexasters. 300  $\times$ .

Figs. 4-7. Oxyhexasters. 300  $\times$ .

Fig. 8. Microdiscohexaster. 300  $\times$ .

Fig. 9. Dermalia. 300  $\times$ .

Fig. 10. Gastralia. 300  $\times$ .

Fig. 11. Showing the spiculation of the wall. Above, a conulus with a tuft of prostalia. 20  $\times$ .

Fig. 12. A small part of a section through the body-wall, stained with hæmatoxylin. Above, two dermalia and the dermal membrane. The latter connected with the choanosome by a pillar consisting of spicules and a dense cobweb of trabeculæ. Below, parts of two flagellated chambers. 100  $\times$ .

Fig. 13. A gastralia with the free ray directed downwards, and the trabecular cobweb in connection with it. 100  $\times$ .

Fig. 14. Chamber wall (membrana reticularis) in optical section. 1000  $\times$ .

Fig. 15. Same in surface-view. Below, a group of strongly stained archaeocytes. 1000  $\times$ .

Figs. 16-23. *Acanthascus alani* Ir.

P. 158.

Fig. 16. The type-specimen now belonging to the British Museum.  $\frac{1}{2}$  nat. size.

Fig. 17. Dermalia. 300  $\times$ .

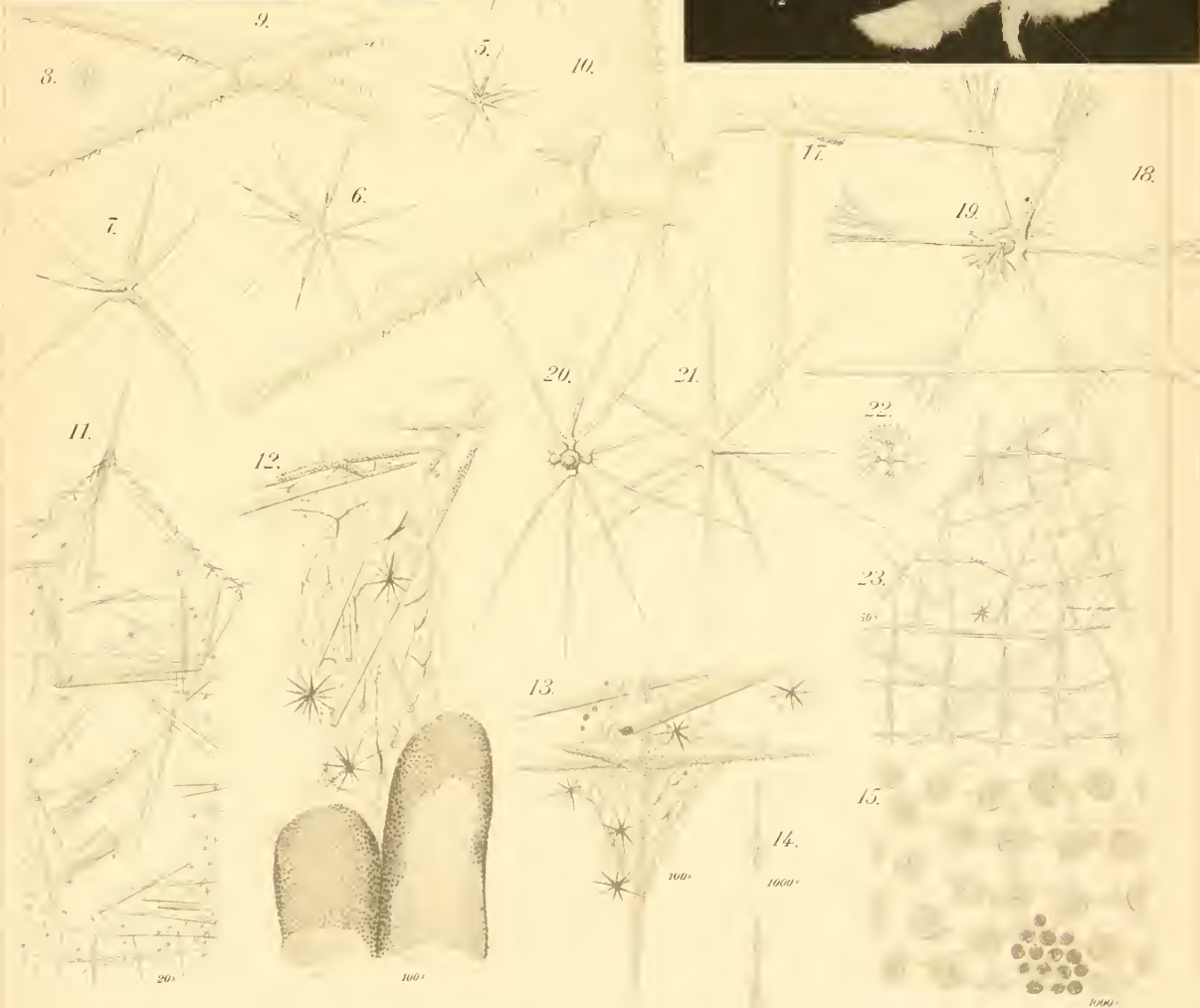
Fig. 18. Gastralia. 300  $\times$ .

Fig. 19. Discoctaster. 300  $\times$ . (The terminals are drawn a little too thick.)

Figs. 20, 21. The two varieties of oxyhexaster. 300  $\times$ .

Fig. 22. Microdiscohexaster. 300  $\times$ .

Fig. 23. Skeletal parts of the ectosome: dermal lacework and hypodermal strands. 50  $\times$ .



1-15. *Aulosaccus mitsukurii* IJ.  
16-23. *Acanthascus alani* IJ.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

## PLATE XI.

*Staurocalyptus heteractinus* IJ.

*Staurocalyptus* sp.

*Acanthascus cactus* F. E. SCH.

## Plate XI.

Figs. 1-10. *Staurocalyptus heteractinus* L.

P. 218.

- Fig. 1. The type-specimen (S. C. M. No. 409). Nat. size.
- Fig. 2. Hypodermal pentactin. 150  $\times$ .
- Figs. 3, 4. A large and a small stauractinic dermalia. 300  $\times$ .
- Fig. 5. Gastral pentactin. 300  $\times$ .
- Fig. 6. Discoctaster from the deeper part of the wall. 300  $\times$ .
- Fig. 7. Oxyhexaster from the periphery. 300  $\times$ .
- Fig. 8. Same from a deep part. 300  $\times$ .
- Fig. 9. Microdiscohexaster. 300  $\times$ .
- Fig. 10. Spiculation of the wall. Combination figure. About 30  $\times$ .

Figs. 11-15. *Staurocalyptus* sp.

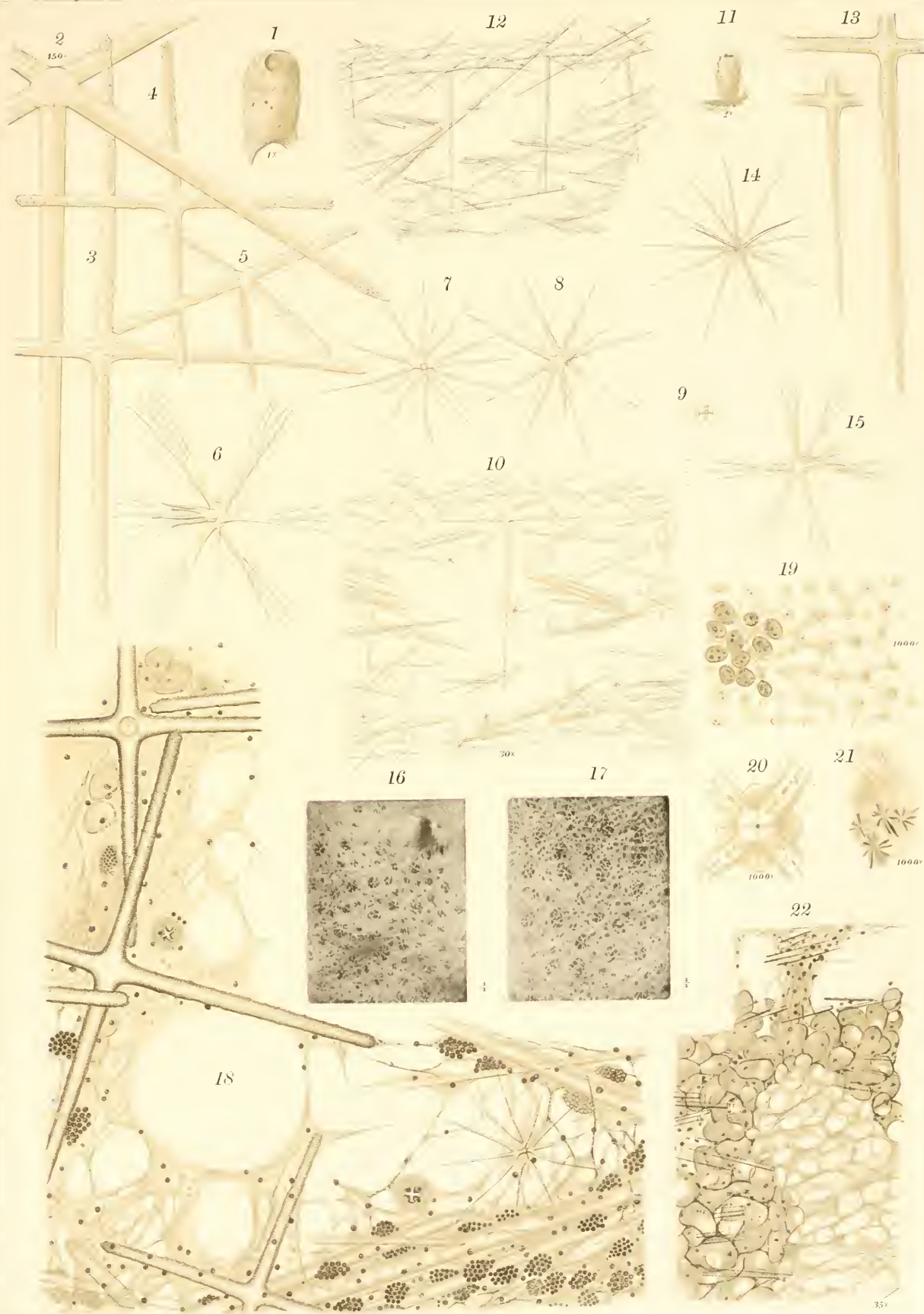
P. 235.

- Fig. 11. The entire specimen, attached to a dead *Hexactinella*. 2  $\times$ .
- Fig. 12. Spiculation of the wall. Combination figure.
- Fig. 13. Portions of large and small dermal stauractins. 300  $\times$ .
- Fig. 14. Oxyhexaster. 300  $\times$ .
- Fig. 15. Discoctaster. 300  $\times$ .

Figs. 16-22. *Acanthascus cactus* F. E. Sch.

P. 140.

- Fig. 16. Gastral surface of a dried specimen, showing the endosomal latticework covering the excurrent canalar apertures. Nat. size.
- Fig. 17. Dermal surface of the same, showing the ectosomal latticework, beneath which are visible the incurrent canalar apertures. Nat. size.
- Fig. 18. Portion of a tangential section of the wall, with soft parts stained with hæmatoxylin. 300  $\times$ . To the left, dermal membrane with dermalia, etc. To the right, subdermal trabeculae and spicules. Thesocytes visible as masses of fat-like spherules.
- Fig. 19. Reticular chamber-wall in surface-view; with a small group of deeply stained archæocytes. 1000  $\times$ .
- Fig. 20. Central node of a small discoctaster from subdermal region. The central axial cross drawn in as seen in glycerine-mounted preparations. 1000  $\times$ .
- Fig. 21. Peculiar rosette-like groups of deeply stained rod-like or spindle-like bodies, found on soft tissues of a specimen hardened in absolute alcohol and stained with borax-carmin. 1000  $\times$ .
- Fig. 22. Portion of a section through the wall, with soft parts stained with hæmatoxylin. Above, the dermal layer or ectosome and the subdermal space traversed by a pillar. Below and to the right, an excurrent canal with apophyses of chambers seen *en face*. About 35  $\times$ .



1—10. *Staurocalyptus heteractinus* Ij. 11—15. *Staurocalyptus* sp.

16—22. *Acanthascus cactus* F. E. Sch.



I. LIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XII.

*Acanthascus cactus* F. E. Sch.

## Plate XII.

*Acanthascus cactus* F. E. Sch.

P. 140.

- Fig. 23. Stauractinic dermalia in lateral view. 300  $\times$ .  
Fig. 24. Pentactinic gastralial in lateral view. 300  $\times$ .  
Fig. 25. Peripheral discoctaster. 300  $\times$ .  
Fig. 26. Microdiscohexaster. 300  $\times$ .  
Fig. 27. Discoctaster from subgastral region. 300  $\times$ .  
Fig. 28. End of a terminal of a subgastral discoctaster. Very highly magnified.  
Fig. 29. Oxyhexaster, in which each nearly atrophied principal seems to bear two terminals. 300  $\times$ .  
Fig. 30. Hemihexactinose oxyhexaster. 300  $\times$ .  
Fig. 31. Hexactinose oxyhexaster. 300  $\times$ .  
Fig. 32. Oxyhexaster with four terminals to each principal. A rare form. 300  $\times$ .  
Fig. 33. Abnormal oxyhexaster, only once met with. 300  $\times$ .  
Fig. 34. Ectosome in surface-view, showing the dermal lacework, the hypodermal strands and the perforated dermal membrane. The larger black dots in the last represent deeply stained thesocytes. About 45  $\times$ .  
Fig. 35. Endosome in surface-view, showing the perforated gastral membrane and the various spicules found in and below it. Black dots as in last figure. About 45  $\times$ .  
Fig. 36. Ends of parenchymalia of various sizes. 100  $\times$ .  
Fig. 37. Small portion of basidictyonal framework. 100  $\times$ .



23.

24.

25.

26.

27.

28.

29.

30.

31.

32.

33.

34.

35.

a

b

c

d

e

100x

45x

36.

100x

45x



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XIII.

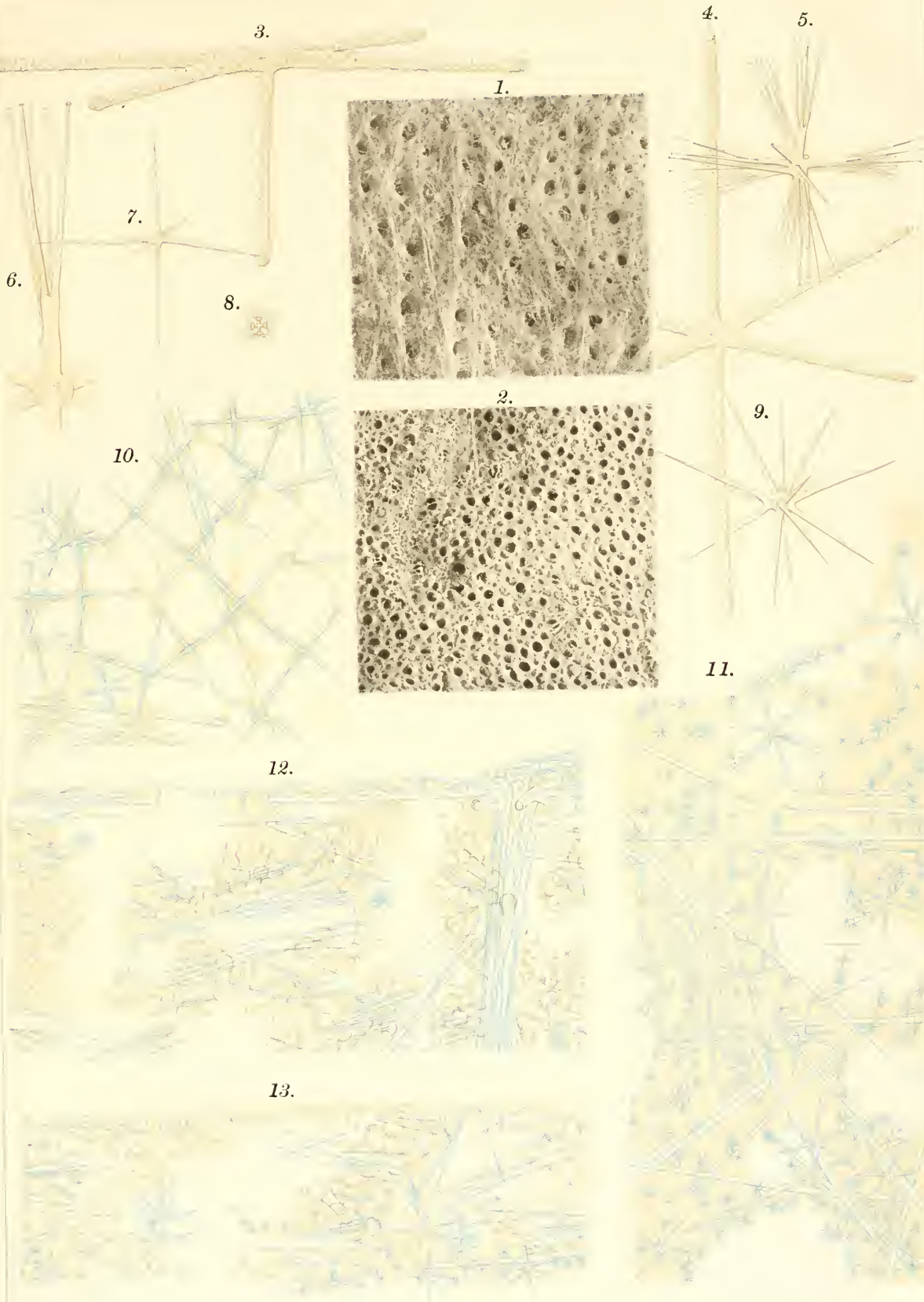
*Staurocalyptus affinis* n. sp.

### Plate XIII.

*Staurocalyptus affinis* n. sp. P. 180.

All figures from Sci. Coll. Mus. Sp. No. 194.

- Fig. 1. External surface of the wall. Dermal spicules wanting in the greater part. Nat. size.
- Fig. 2. Gastral surface of the same. Canalar apertures mostly freely open but some covered with small-meshed endosomal lattice which is differentiated in irregular patches. Nat. size.
- Fig. 3. Dermalia. 300  $\times$ .
- Fig. 4. Gastralial. 300  $\times$ .
- Fig. 5. Small discoctaster from subdermal space; imperfectly developed in so far as some terminals remain isolated from the secondary principals. 300  $\times$ .
- Fig. 6. Part of a larger discoctaster from the subgastral space. 300  $\times$ .
- Fig. 7. Hexactinose oxyhexaster from choanosome. 300  $\times$ .
- Fig. 8. Microdiscohexaster.
- Fig. 9. Smooth-rayed oxyhexaster from endosome. 300  $\times$ .
- Fig. 10. Small portion of ectosome in surface view. Dermalia and hypodermalia held together by desiccated soft tissue. 60  $\times$ .
- Fig. 11. Small portion of endosome in surface view. 60  $\times$ .
- Fig. 12. Peripheral portion of a section through the wall. Above, dermal surface. To the right, a group of paratropal hypodermal pentactins. In the center, the central portion of a large parenchymal principalia, surrounded by comitalia. 30  $\times$ .
- Fig. 13. Portion adjoining the gastral surface of a section through the wall. Below, the gastral surface. 30  $\times$ .



*Staurocalyptus affinis* Ij.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

## PLATE XIV.

*Staurocalyptus affinis* n. sp.

*S. entacanthus* n. sp.

*S. roeperi* (F. E. SCH.).

## Plate XIV.

*Staurocalyptus affinis* n. sp.

P. 180.

- Fig. 14. The smaller of the two type specimens of *S. affinis* (Sc. Coll. Mus. No. 400). About  $\frac{2}{3}$  nat. size.
- Fig. 16. Smooth-rayed oxyhexaster from gastral side. 300  $\times$ . (From Sp. No. 400).
- Fig. 17. Rough-rayed oxyhexaster from subdermal space. 300  $\times$ . (From Sp. No. 400).
- Fig. 22. Two rudimentary oxyhexasters (early developmental stage?). 300  $\times$ . (From Sp. No. No. 400).
- Fig. 23. Central node of a discoctaster, showing the disposition of axial filaments. Seen in glycerine. 1200  $\times$ . (From Sp. No. 194).
- Fig. 24. Central node of an oxyhexaster, showing the axial cross of filaments. Seen in glycerine. 1200  $\times$ . (From Sp. No. 194).
- Fig. 25. Central node of a hexactinose oxyhexaster, showing the axial cross of filaments. Seen in glycerine. 1200  $\times$ . (From Sp. No. 194).

*Staurocalyptus entacanthus* n. sp.

P. 191.

- Fig. 15. The type specimen (Sc. Coll. Mus. No. 242), a fragment from the oscular margin of a large individual. Seen from the dermal side. Marginal lappets reflected outwards and backwards, thus showing the spiny gastral surface. About  $\frac{1}{2}$  nat. size.
- Fig. 18. Subdermal trabeculae, showing four thesocytes. Fixed with alcohol and stained with hæmatoxylin. 440  $\times$ .

*Staurocalyptus entacanthus*?

Pp. 194 & 198.

Sc. Coll. Mus. No. 403, which specimen is shown in these Studies,  
Contrib. III., Pl. VI., figs. 9 and 10, under the name  
of *S. japonicus*.

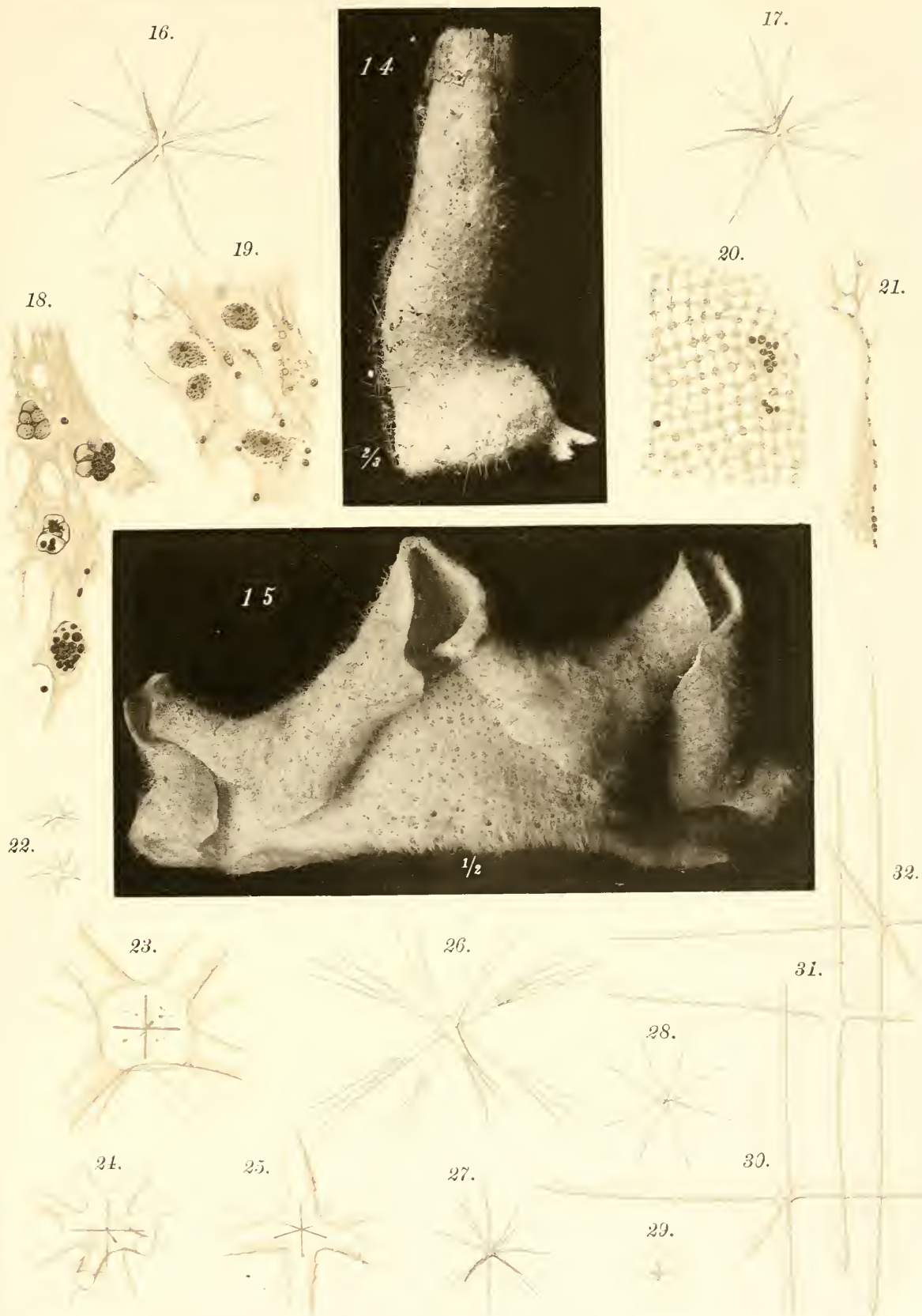
- Fig. 19. Trabecular tissue, with four thesocytes, from along the lumen of an incurrent canal. Alcohol and hæmatoxylin. 440  $\times$ .
- Fig. 20. Chamber-wall, seen surface on. Well-stained archaeocytes in small groups. Alcohol and hæmatoxylin. 440  $\times$ .
- Fig. 21. Same in optical section. 440  $\times$ .

*Staurocalyptus ræperi* (F. E. SCHL.).

P. 168.

All figures from F. E. SCHULZE's type-specimen, obtained  
by the "Challenger."

- Fig. 26. Discoctaster. 300  $\times$ .
- Fig. 27. Oxyhexaster, from gastral side. 300  $\times$ .
- Fig. 28. Another oxyhexaster, in which each principal bears, besides two well-developed terminals, a minute rudiment of a third terminal. 300  $\times$ .
- Fig. 29. Microdiscohexaster from gastral surface. 300  $\times$ .
- Fig. 30. Pentactinic dermalia. 300  $\times$ .
- Fig. 31. Stauractinic dermalia. 300  $\times$ .
- Fig. 32. Gastralia. 300  $\times$ .



14, 16, 17, 22-25. *Staurocalyptus affinis* IJ. 15, 18. *St. entacanthus* IJ.  
19-21. *St. entacanthus*? 26-32. *St. roeperi* (F. E. SCH.)



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STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XV.

*Staurocalyptus glaber* IJ.

## Plate XV.

*Staurocalyptus glaber* L.

P. 207.

- Fig. 1. A large specimen attached to a dead *Periphragella elise* (Sci. Coll. Mus. No. 244).  $\frac{1}{2}$  nat. size.
- Fig. 2. Another attached to a specimen of a tufaceous bottom (Sci. Coll. Mus. No. 398).  $\frac{1}{2}$  nat. size.
- Fig. 3. Two young specimens attached to a dead *Chonelasma calyx*. Nat. size.
- Figs. 4-6. Dermalia in different views. 300  $\times$ .
- Fig. 7. Gastralia. Below, the free proximal ray. 300  $\times$ .
- Fig. 8. Microdiscohexaster. 300  $\times$ .
- Fig. 9. Discoctaster. 300  $\times$ .
- Fig. 10. Oxyhexaster. 300  $\times$ .
- Fig. 11. Portion of a longitudinal section through the wall of a young specimen. Above, the oscular edge. 30  $\times$ .
- Fig. 12. Small portion of the basidictyonal plate. 100  $\times$ .
- Fig. 13. One of the small basidictyonal masses, found in abundance in the parenchyma of Sci. Coll. Mus. No. 361,—probably basidictyonalia belonging to a young brood which had fixed themselves, temporarily or otherwise, to the parenchymalia of the mother-sponge. 50  $\times$ .



4.

5.



6.

9.

10.

7.

8.

11.

12.

100x

35x



13.

50x

*Staurocalyptus glaber* Ij.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XVI.

*Staurocalyptus pleorhaphides* IJ.

## Plate XVI.

*Staurocalyptus pleorhaphides*. 13.

P. 222.

- Fig. 1. S. C. M. No. 226. A part of the wall cut off and the gastral surface exposed. Nat. size.
- Fig. 2. Another entire specimen. S. C. M. No. 415. Nat. size.
- Figs. 3-5. Dermalia. 300  $\times$ .
- Fig. 6. Gasteral diactin of a moderately large size. 300  $\times$ .
- Fig. 7. Normally developed oxyhexaster. 300  $\times$ .
- Fig. 8. Malformed oxyhexaster, observed but once. 300  $\times$ .
- Fig. 9, 10. Discocasters of the larger size. 300  $\times$ .
- Fig. 11. Part of a very small discocaster. 300  $\times$ .
- Fig. 12. Microdiscohexaster. 300  $\times$ .
- Fig. 13. Part of the paratangential ray of a proctal pentactin, to show the roughness of surface caused by minute and pointed microtubercles. 300  $\times$ .
- Fig. 14. Spicules in and on a conulus of the sponge-surface. Two proctal, paratropal oxypentactins and a part of a proctal oxydiactin. About 30  $\times$ .
- Fig. 15. Surface view of the ectosome, with dermalia which are mostly diactins. 60  $\times$ .
- Fig. 16. Surface view of the endosome, with diactinic gastralia. 60  $\times$ .



*Staurocalyptus pleorhaphides* IJ.





L. JIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XVII.

*Rhabdocalyptus victor* Ij.

**Plate XVII.**

*Rhabdocalyptus victor* B.

P. 238.

Fig. 1. Sci. Coll. Mus. No. 423. Slightly less than  $\frac{1}{4}$  nat. size. Total length 880 mm.; diameter at middle 220-270 mm.



*Rhabdocalyptus victor Ij.*



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XVIII.

*Rhabdocalyptus victor* IJ.

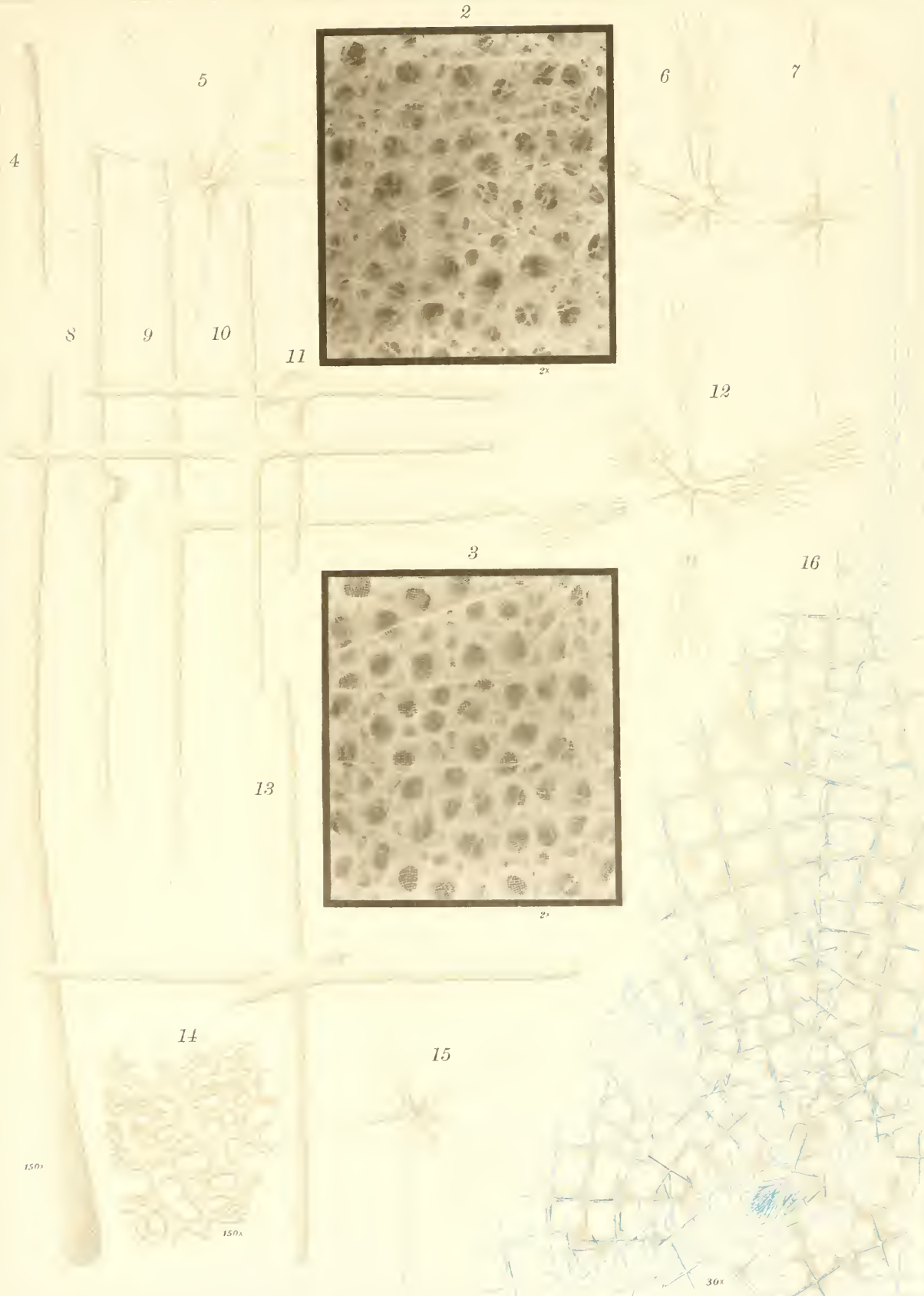
## Plate XVIII.

*Rhabdocalyptus victor* L.

P. 238.

- Fig. 2. A portion of the dermal surface, magnified about two diameters. Dermal lacework, blurred. Hypodermal strands radiating from several central points.
- Fig. 3. A portion of the gastral surface, magnified about two diameters. Gastral lacework supported on hypogastral strands, covering the excurrent canalar apertures.
- Fig. 4. A large, unequally rayed, parenchymal diactin from the basal region. 150  $\times$ .
- Fig. 5. A hemihexactinose oxyhexaster with nine terminal points. 300  $\times$ .
- Fig. 6. Portion of a discoctaster, with a primary terminal which has remained free, unfused with the secondary principal running by its side. 300  $\times$ .
- Fig. 7. A hexactinose oxyhexaster. 300  $\times$ .
- Figs. 8-11. Different forms of dermalia, the stauractinic form of fig. 10 being by far the most common. 300  $\times$ .
- Fig. 12. A discoctaster, with plain central node. 300  $\times$ .
- Fig. 13. A gastral hexactin. 300  $\times$ .
- Fig. 14. A small portion of the basidictyonal plate. 150  $\times$ .
- Fig. 15. A hemihexactinose oxyhexaster with seven terminal points. 300  $\times$ .
- Fig. 16. A small portion of the ectosome, seen from outside; including a group of hypodermal pentactins with the paratangentials in a radial disposition. In the center of the group, a dense projecting tuft of fine diactins. 30  $\times$ .





*Rhabdocalyptus victor* Ij.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XIX.

*Rhabdocalyptus victor* Ij.

## Plate XIX.

*Rhabdocalypus victor* L.

P. 238.

- Fig. 17. A young specimen (S. C. M. No. 227) attached to a *Hexactinella lorica*. Nat. size.
- Fig. 18. Portion of the longitudinal section of a young specimen. Above, the oscular edge; at the middle, the irregularly wavy chamber-layer which loses itself close to the oscular edge. About 30  $\times$ .
- Fig. 19. Free edge of chamber-wall, gradually passing into trabeculae. 440  $\times$ . This figure, as also all the following figures, was taken from a young specimen of the size of a small apple, hardened in alcohol and stained with hæmatoxylin.
- Fig. 20. Small portion of a section, drawn with the microscope focussed at apophyses of chambers. 300  $\times$ . *c.*, old and empty thesocytes. The darkly stained bodies are thesocyte spheres. *e.*, free edge of apophyse. *f.*, film-like connecting membrane covering the gap between four adjoining apophyses. *g.*, freely communicating gap (without a connecting membrane) between apophyses.
- Fig. 21. Portion of a paratangential section passing near the gastral surface. About 40  $\times$ . *ex.*, excurrent canals in cross-section. *in.*, intercommunicating lacunæ, the ultimate end of the incurrent canal system.
- Fig. 22. Portion of a similar section, passing through the periphery of the choanosome. About 40  $\times$ . Lettering as in above. Here the ultimate branches of excurrent canals are seen to form anastomosing lacunæ around the stem of incurrent canals.
- Fig. 23. Constructed figure to show in section the branching of canals and the folding of the chamber-layer. Above, the dermal surface is supposed to be seen in a slanting away position. *in.*, *ex.*, wall of incurrent and excurrent canals seen *en face*. Below, the continuous gastral layer.



*Rhabdocalyptus victor* Ij.





I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XX.

*Rhabdocalyptus mollis* F. E. SCH.

## Plate XX.

*Rhabdocalyptus mollis* F. E. Sch.

P. 253.

- Fig. 1. A specimen (O. C. No. 103) well preserved, except in that a bud has been torn off.  $\frac{1}{4}$  natural size.
- Fig. 2. A specimen (S. C. M. No. 420) from which a triangular piece of the wall had been cut away.  $\frac{1}{4}$  natural size. (Figs. 3-9 were all taken from this specimen).
- Fig. 3. A normal oxyhexaster from the subdermal space. 300  $\times$ .
- Fig. 4. Microdiscohexaster. 300  $\times$ .
- Fig. 5. Discoctaster. 300  $\times$ .
- Fig. 6. A hemihexactinose oxyhexaster with 10 terminals in all, from deep parts. 300  $\times$ .
- Fig. 7. A hexactinose oxyhexaster; two of the straight rays each showing at base the remnant of an atrophied terminal in the form of a unilateral spine. 300  $\times$ .
- Fig. 8. A quite hexactinose oxyhexaster. 300  $\times$ .
- Fig. 9. Another hexactinose oxyhexaster with all the rays crooked at base. 300  $\times$ .
- Fig. 10. A nearly hexactinose oxyhexaster; one of the rays is simply bent at base, while another similarly bent ray shows the rudiment of a fellow terminal belonging to the same principal. From O. C. No. 104. 300  $\times$ .
- Fig. 11. A hemihexactinose oxyhexaster with very strongly developed basal barbs to the rays. From O. C. No. 104. 300  $\times$ .
- Fig. 12. Spicules of ectosome seen in surface view. From S. C. M. No. 420. 30  $\times$ .
- Fig. 13. Spicules of endosome seen in surface view. From S. C. M. No. 420. 30  $\times$ .



*Rhabdocalyptus mollis* F. E. Sch



I. IJIMA.

STUDIES ON THE HEXACHINELLIDA. CONTRIBUTION IV.

PLATE XXI.

*Rhabdocalyptus unguiculatus* Ij.

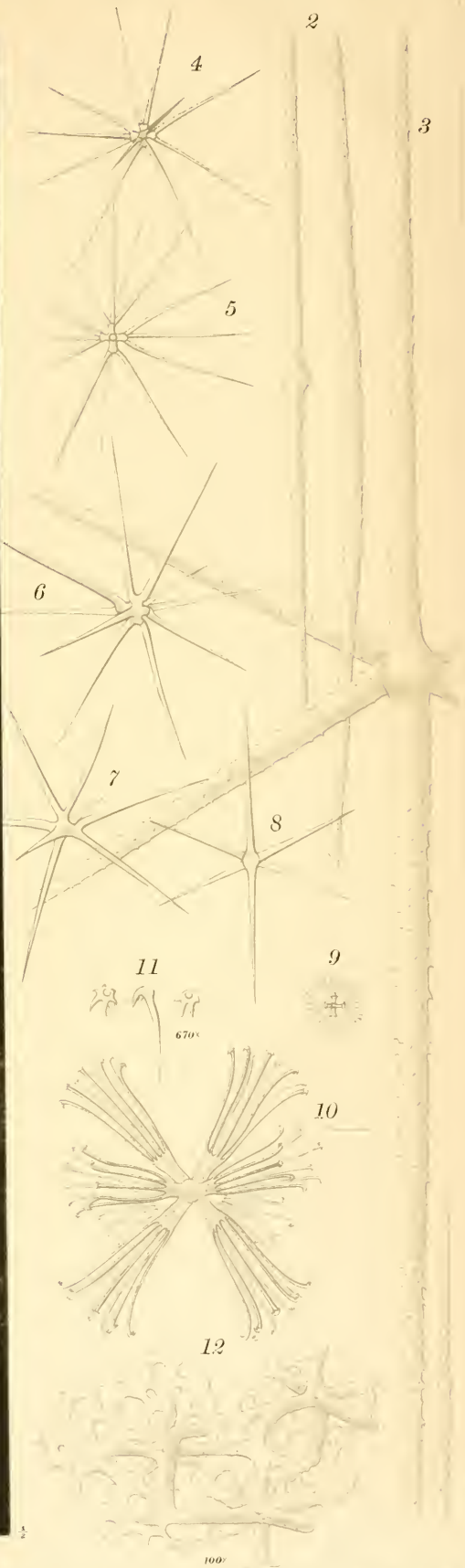
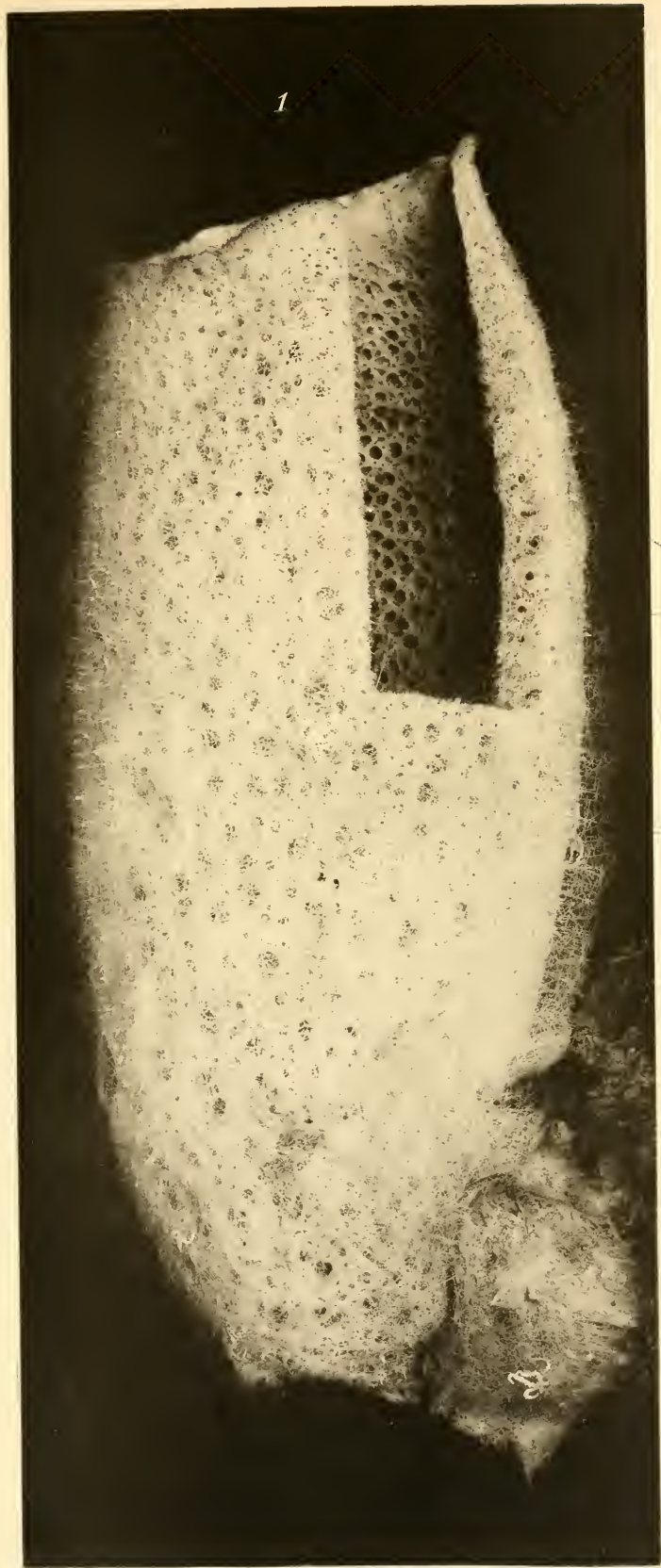
## Plate XXI.

*Rhabdocalyptus unguiculatus* Is.

P. 268.

- Fig. 1. The type-specimen (Sci. Coll. Mus. No. 501).  $\frac{1}{2}$  natural size.  
All the following figures of spicules were taken from this specimen.
- Fig. 2. Two dermal diactins.  $300\times$ .
- Fig. 3. A gastral hexactin.  $300\times$ .
- Figs. 4, 5. Thin-rayed oxyhexasters from the periphery of the sponge wall.  $300\times$ .
- Figs. 6, 7. Stronger-rayed, smooth, hemihexactinose oxyhexasters from the gastral side of the sponge wall.  $300\times$ .
- Fig. 8. Hexactinose oxyhexaster from the same region.  $300\times$ .
- Fig. 9. Microdiscohexaster from the dermal membrane.  $300\times$ .
- Fig. 10. A discoctaster.  $300\times$ .
- Fig. 11. Unguiculate terminal discs of discoctaster. One in lateral view; two as seen from above.  $670\times$ .
- Fig. 12. A small fragment from the basidictyonal plate. The small-meshed limiting layer and some basidictyonal hexactins in fusion with it as well as with one another.  $100\times$ .





*Rhabdocalyptus unguiculatus* IJ.



I. IJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XXII.

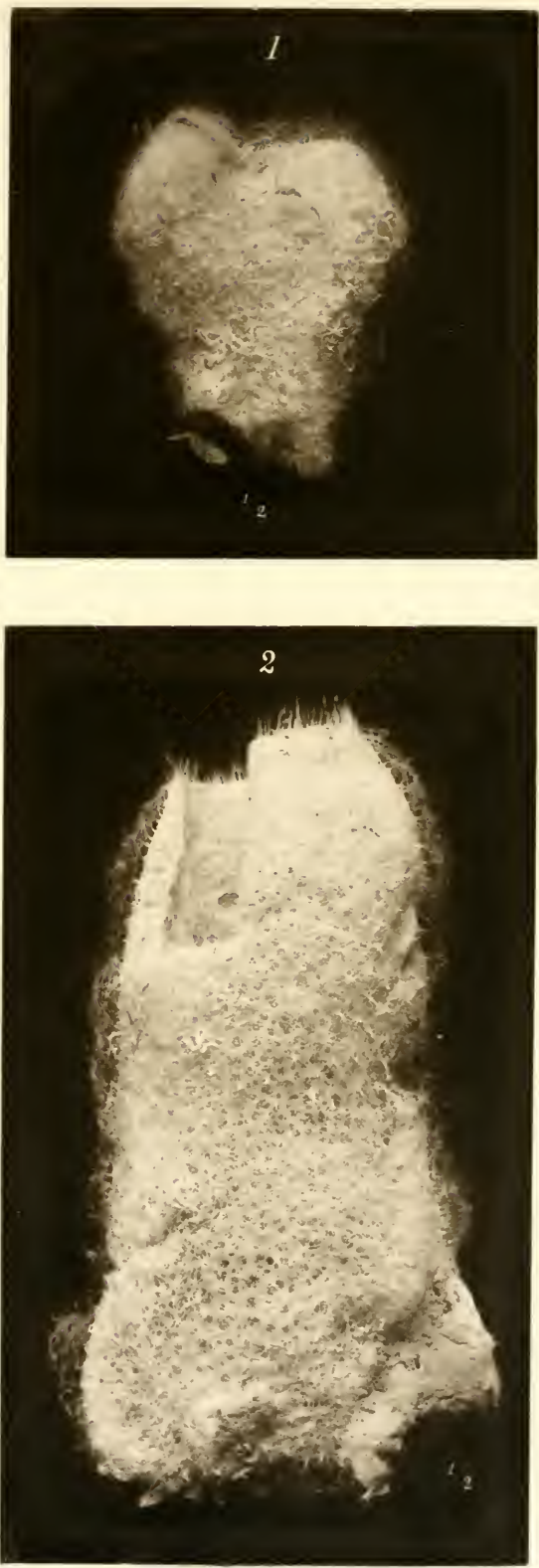
*Rhabdocalyptus capillatus* IJ.

## Plate XXII.

*Rhabdocalyptus capillatus* LI.

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- Fig. 1. A specimen from Inside Okinosé by the Ena-line (S. C. M. No. 287).  $\frac{1}{2}$  nat. size.
- Fig. 2. Another from Outside Okinosé by the Iwado-line (S. C. M. No. 397).  $\frac{1}{2}$  nat. size.
- Figs. 3, 4. Two very small specimens from a lot of six, all of which were found attached to a dead *Chonelasma calyx* from Maye-no-Yodomi (S. C. M. No. 406). Nat. size.
- Fig. 5. A young specimen from a lot of three, found attached to a dead *Chonelasma calyx* from Mochiyama (S. C. M. No. 413). Nat. size.
- Fig. 6. Dermalia. 300  $\times$ .
- Figs. 7, 8. Oxyhexasters from subdermal space. 300  $\times$ .
- Figs. 9, 10. Discotasters. 300  $\times$ .
- Fig. 11. Microdiscohexaster. 300  $\times$ .
- Fig. 12. Wall of dried specimen in section. The arrows indicate incurrent and excurrent canals. 2  $\times$ .
- Fig. 13. Gastralia. 300  $\times$ .
- Figs. 14, 15. Oxyhexasters from subgastral space. 300  $\times$ .
- Fig. 16. Arrangement of the paratangential heads of hypodermal pentactins in groups. About 4  $\times$ .
- Fig. 17. Part of basidictyonal plate. 100  $\times$ .



*Rhabdocalyptus capillatus* Ij





I. UJIMA.

STUDIES ON THE HEXACTINELLIDA. CONTRIBUTION IV.

PLATE XXIII.

*Rhabdocalypus capillatus* Ij.

### Plate XXIII.

*Rhabdocalyptus capillatus* Is.

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(All figures from sections stained with borax-carminc).

Fig. 18. Surface view of ectosome. 300  $\times$ .

Fig. 19. A small part of the subdermal region. Below, blind end of a chamber and a small (young) oxyhexaster. 300  $\times$ .

Fig. 20. A small part of chamber wall. Below, three archæocytes. 1000  $\times$ .

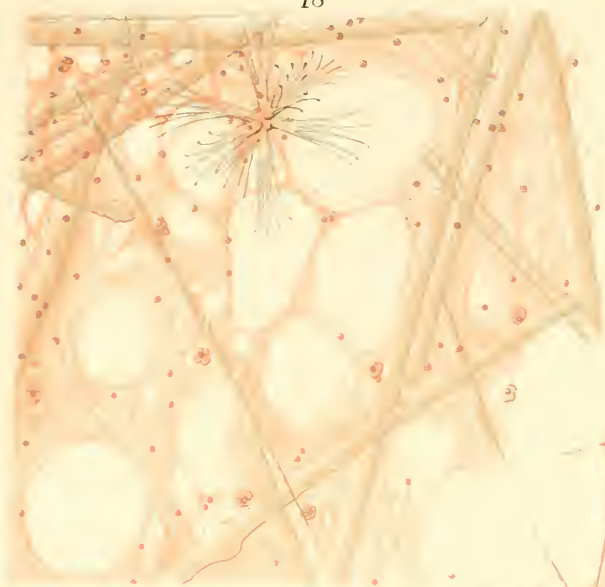
Fig. 21. Thesocytes of varied appearance. 1000  $\times$ .

Fig. 22. Peripheral part of a section vertical to the surfaces. 30  $\times$ . Above, dermal surface; *s. s.*, subdermal space; *in.*, incurrent canal; *ex.*, excurrent canal.

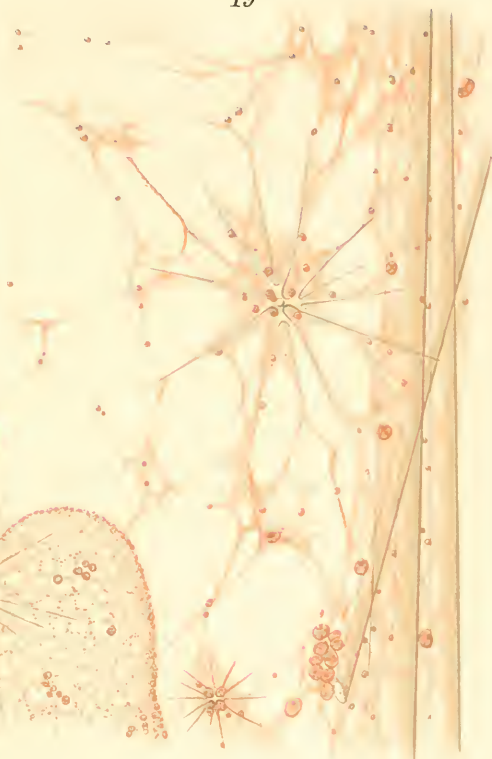
Fig. 23. Part of a paratangential section. 30  $\times$ . *in.*, intercommunicating incurrent spaces; *ex.*, excurrent canal.

Fig. 24. Gastral part of a section vertical to the surfaces. 30  $\times$ . Below, the gastral surface. Lettering as in the above figure.

18



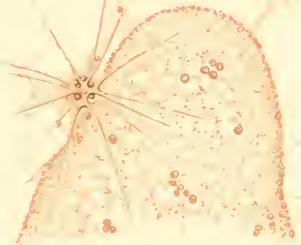
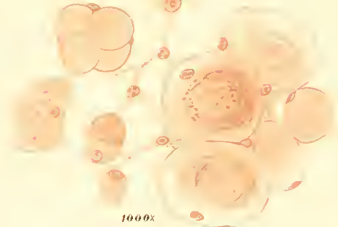
19



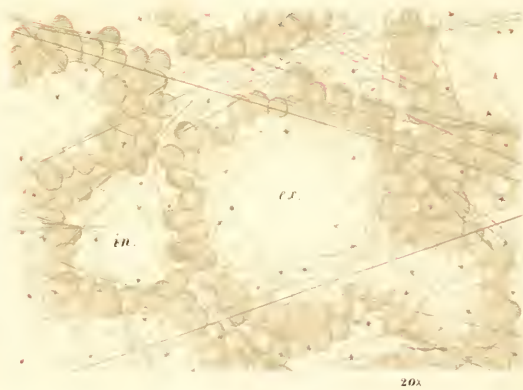
20



21



23

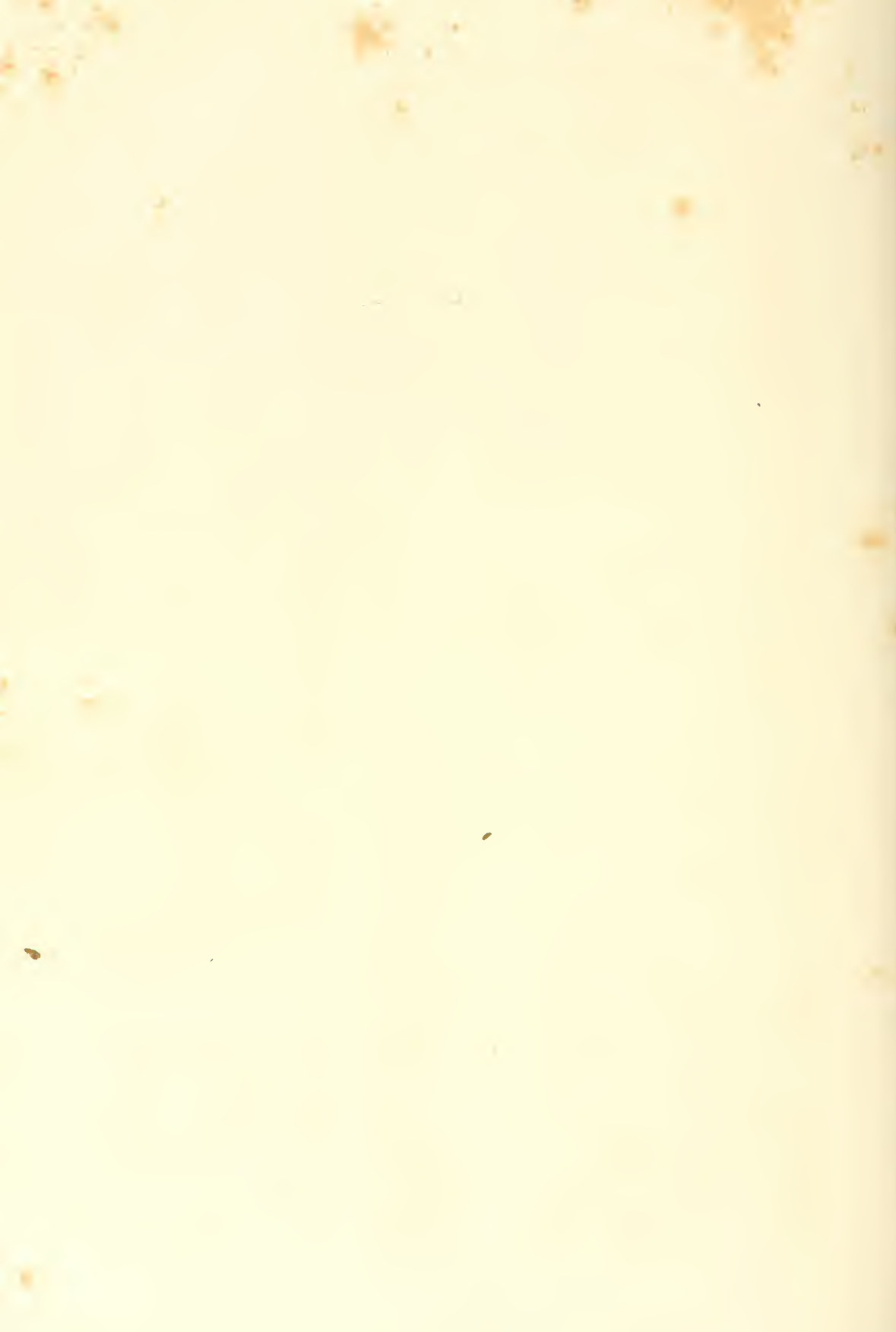


22



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- A. Capitula unisexualia .....14. Xanthium.  
 B. Capitula bisexualia.  
   a). Plantae non lactantes, capitula hetero-homogama; disciflores tubuliformes.  
     a. Antherae basi ecaudatae.  
       ○ Capitula homogama.  
         □ Involueri bractae omnino liberae.  
           △ Achaenia laevia v. pubescentia.  
             \* Styli rami subulati hirtelli.  
               † Capitula discreta, multi-flora .....1. Vernonia.  
               †† Capitula in plurima glomerulum aggregata,  
                   pauci-flora .....2. Elephantopus.

- \*\* Styli rami obtusi, papilloși.
  - † Anthere apice truncatæ .....3. Adenostemma.
  - †† Anthere apice appendiculatæ.
    - ‡ Pappus paleaceus. ....4. Ageratum.
    - ‡‡ Pappus setosus.
      - § Involuceri bractee 5— $\infty$ . 5. Eupatorium.
      - §§ Involuceri bractee 4. ....6. Mikania.
  - △△ Achaenia ciliata. ....18. Spilanthes.
- Involuceri bractee plus minus coherentes.
  - △ Bracteola parva. ....26. Gynura.
  - △△ Bracteola 0. ....27. Emilia.
- Capitula heterogama.
  - Pappus setosus, copiosus.
    - △ Capitula radiata.
      - \* Involuceri bractee pluri-seriatæ omnino liberæ.
        - † Corollæ omnes flavæ.....7. Solidago.
        - †† Corollæ radii violaceæ.....10. Aster.
      - \*\* Involuceri bractee sub-1-seriatæ, plus minus coherentes.....28. Senecio.
    - △△ Capitula disciformia.
      - \* Fl. ♀ tubuliformes. ....12. Conyza.
      - \*\* Fl. ♀ liguliformes, filiformes.
        - † Achaenia 2-costata. ....11. Erigeron.
        - †† Achaenia 4-5-costata. ....13. Microglossa.
  - Pappus 0 v. 2-3-aristis v.-paleis constans.
    - △ Styli rami complanati v. subteretes obtusi, acuti v. acuminati.
      - \* Receptaculum nudum.
        - † Capitula radiata. ....10. Aster.
        - †† Capitula disciformia.
          - ‡ Pappus 2-3-setulis constans..8. Dielrocephala.
          - ‡‡ Pappus 0; achaenia apice in collum margine ciliatum producta. ....9. Grangea.
      - \*\* Receptaculum paleaceum.



† Pappus paleaceus v. o.

‡ Involueri interiores bracteæ  
achænia amplexantes ...15. Siegesbeckia.

‡‡ Involueri interiores bracteæ  
achænia non amplexantes.....

§ Paleæ receptaculi planæ,  
angustæ .....16. Eclipta.

§§ Paleæ receptaculi concavæ..17. Wedelia.

†† Pappus aristatus.

‡ Folia opposita.....19. Bidens.

‡‡ Folia alterna. ....20. Glossogyne.

△△ Styli rami truncati penicillati.

\* Capitula radiata.

† Involuerum cylindraceum, bracteis  
1-seriatis, æqualibus alte connatis ...21. Tagetes.

†† Involuerum hemisphaericum bracteis  
∞-seriatis imbricatis appressis.....  
22. Chrysanthemum.

\*\*\* Capitula disciformia.

† Achænia pilosa, pilis glochidiatis...23. Myriogyne.

†† Achænia laevia glandulosa.

‡ Achænia subteretia v. compressa.

2-costata v. ecostata ; herbæ ...24. Artemisia.

‡‡ Achænia 5-gona ; frutices.....

\* 25. Crossostephium.

β. Anthere basi caudatæ.

○ Capitula heterogama.

□ Involueri bracteæ ∞-seriatæ, imbricatæ, acutæ, lineares,  
molles. ....29. Blumea.

□□ Involueri bracteæ ∞-seriatæ imbricatæ apice fere  
undique scariosæ, ovatæ, obtusæ.

△ Suffrutices glabrati.

\* Capitula in cymas corymbosas aphyllas  
terminales disposita .....30. Pluchea.

\*\*\* Capitula terminalia solitaria .....32. Carpesium.

△△ Herbæ cano-tomentosæ lanatæ.....31. Gnaphalium.

○○ Capitula homogama.

□ Capitula 1-flora, in glomerulos densos capituliformes  
aggregata. ....33. Echinops.

□□ Capitula ∞-flora, discreta.

- △ Filamentæ papilloso-hirsutæ .....34. Cnicus.  
 △△ Filamentæ glabræ.....35. Saussurea.
- b). Plantæ lactantes ; capitula homogama, corollæ omnes ligulatæ.
- α. Achænia non rostrata.
- Achænia subteretia, apice constricta attenuata, basi  
 brevissime contracta .....36. Crepis.
- Achænia leviter compressa, basi-apiceque parum  
 contracta .....38. Lactuca.
- β. Achænia rostrata.
- Scapi erecti, aphylli, 1-cephali.....37. Taraxacum.
- Capitula secus ramos sessilia v. pedunculata, paniculata.....  
 39. Sonchus.

## 1. *Vernonia* SHREB.

### *Conspectus Specierum.*

Capitula majuscula,  $1\frac{1}{2}$  cm. longa. ....1. *V. Andersoni*.

Capitula parva,  $\frac{1}{2}$  cm. longa.

Folia ovato-lanceolata v. lanceolata ; achænia teretia.....2. *V. cinerea*.

Folia elliptica v. ovata ; achænia 4-costata .....3. *V. chinensis*.

**1. *V. Andersoni*** CLARKE, Comp. Ind. p. 26 ; Hook. f. Fl. Brit. Ind. III, p. 241 ; FORBES et HEMSL. Ind. Fl. Sin. I, in Journ. Linn. Soc. XXIII, p. 400 ; HENRY, List Pl. Formos. in Trans. As. Soc. Jap. XXIV, Suppl. 1, (1898) p. 51.

*Vernonia Cumingiana* BENTH. Fl. Hongk. p. 170.

Hab. Suitei-riyo, Niki, Nanko, Shifun, C. OWATARI, anno 1897 ; Rinkihō, leg. Y. TASHIRO, anno 1897.

DISTRIB. Assam, Birma, Tanasserim, Hongkong.

**2. *V. chinensis*** LESS. in Linnæa VI, pp. 105 et 674 ; MIQ. Fl. Ind. Bat. II, p. 18 ; BENTH. Fl. Hongk. p. 169 ; CLARKE, Comp. Ind. p. 18 ; HEMSL. in Voy. Chall. Bot. I, part 3, p. 159 ; Hook. f.

Fl. Brit. Ind. III, p. 235 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 401 ;  
HENRY, List Pl. Formosa, p. 51.

*Centratherum chinensis* LESS. in Linnaea, IV, p. 320.

*Cyanopsis pubescens* DC. Prodr. V, p. 69.

*Conyza patula* WILLD. Sp. Pl. III, p. 1919.

Hab. Hōsoan, Shinshoa, leg. H. KAWAKAMI, anno 1895 ;

Taipea, leg. T. MAKINO, anno 1896 ; Pachina, leg.

T. NIINAMI, anno 1897 ; ipse, anno 1900.

DISTRIB. Malaya peninsula et ins. Philipinæ.

**3. V. cinerea** LESS. in Linnaea, IV, p. 291, et VI, p. 673 ; DC.  
Prodr. V, p. 24 ; MIQ. Fl. Ind. Bat. II, p. 11 ; BENTH. Fl. Hongk.  
p. 169 ; HOOKER, Niger Fl. p. 134 ; GRISEBACH, Fl. Brit. West Ind.  
Isl. p. 353 ; BENTH. Fl. Austral. III, p. 459 ; CLARKE, Comp. Ind. p.  
20 ; OLIVER, Fl. Tropic. Africa, p. 275 ; HOOK. f. Fl. Brit. Ind. III,  
p. 235 ; HEMSL. in Voy. Chall. I. part 3, p. 159 ; HILLEBRAND,  
Fl. Hawaiian Isl. p. 191 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 401 ;  
HENRY, List Pl. Formos. p. 51 ; DIELS, Fl. Centr. China, in ENGL.  
Bot. Jahrb. XXIX, (1901) p. 608.

Hab. Shinteku, leg. T. MAKINO, anno 1896 ; Taipea, leg.

C. OWATARI, anno 1897 ; Kuchu, Shintem-koe, leg.

K. MIYAKE, anno 1899 ; Senton, ipse, anno 1900 ;

Pachina, leg. T. NIINAMI.

DISTRIB. Asia tropica, Africa et Australia.

## 2. Elephantopus LINN.

### *Conspectus Specierum.*

Capitulorum glomeruli longe pedunculati, laxissime corymbosi ...1. *E. scaber*.

Capitulorum glomeruli secus ramos floridos elongatos sessiles ...2. *E. spicatus*.

**1. *E. scaber*** LINN. Sp. Pl. ed-2, p. 1313 ; ROXB. Fl. Ind. p. 445 ; LESS. Synop. Comp. p. 149 ; DC. Prodr. V, p. 86 ; HOOKER, Niger Fl. p. 429 ; MIQ. Fl. Ind. Bat. II, p. 21 ; WIGHT, Ind. Ic. Pl. Ind. or. t. 1086 ; BENTH. Fl. Hongk. p. 170, et Fl. Austral. III, p. 461 ; GRISEBACH, Fl. Brit. West. Ind. Isl. p. 354 ; CLARKE, Comp. Ind. p. 28 ; OLIVER, Fl. Tropic. Africa, p. 299 ; HEMSL. in Biol. Central-America. Bot. II, p. 76 ; Hook. f. Fl. Brit. Ind. III, p. 242 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 402 ; HENRY, List Pl. Formos. p. 51.

Hab. Ho-soan, leg. H. KAWAKAMI, anno 1895 ; Shinteku, Taipea, leg. T. MAKINO, anno 1896 ; Kierung, Biyoritsu leg. K. HONDA, anno 1897 ; Ku-chō, Shintem-koé, leg. K. MIYAKE ; Senton, ipse, anno 1900.

DISTRIB. Asia tropica, Africa, et Australia.

**2. *E. spicatus*** B. JUSS. ; LESS. Synop. Comp. p. 149 ; DC. Prodr. V, p. 87 ; GRISEBACH, Fl. Brit. West. Ind. Isl. p. 355 ; HEMSL. in Biol. Central-America. II, p. 76 ; HENRY, List Pl. Formos. p. 51.

Hab. Linga-riyao, Sui-cho-rū, Pak-kan-koe, leg. C. OWATARI, anno 1898 ; Daito, Raikokuwa, Koho, leg. K. MIYAKE, anno 1899.

DISTRIB. America tropica.

### 3. *Adenostemma* FORST.

**1. *A. viscosum*** FORST ; LESS. Synop. Comp. p. 156 ; DC. Prodr. V, p. 111 ; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 181 ; BENTH. Fl. Hongk. p. 171, et Fl. Austral. III, p. 462 ; SEEMANN, Fl. Vitiensis, p. 140 ; FRANCH. et SAV. Enum Pl. Jap. I, p. 219 ; CLARKE, Comp. Ind. p. 28 ; OLIVER, Fl. Tropic. Africa p. 299 ; FRANCH. Pl.

David. p. 159 ; HEMSL. Voy. Chall. Bot. I, part 3, p. 159 ; MIQ. Fl. Ind. Bat. II, p. 23 ; HILLEBRAND. Fl. Hawai. Isl. p. 192 ; MAXIM. in Engl. Jahrb. VI, p. 68 ; HOOK. f. Fl. Brit. Ind. III, p. 242 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 403 ; HENRY, List Pl. Formos. p. 51 ; DIELS, Fl. Centr. China. in Engl. Jahrb. XXIX, p. 608.

*Spilanthes tinctorius* LOUR. Fl. Cochinch. ed-2, p. 484.

Icon. Jap. Somokudzusetz, vol. 16, fol. 15 ; Honzodzufu, vol. 19, fol. 11, verso.

Hab. Kierung, leg. T. MAKINO, anno 1896 ; Urai-gara, Kotosho, Kuchu, Shintemkoe, leg. K. MIYAKE, anno 1899, et leg. T. NIIXAMI, anno 1899.

DISTRIB. Asia tropica, Africa, America, Australia et Japonia.

#### 4. *Ageratum* LINN.

1. *A. conyzoides* LINN. Sp. Pl. ed-2, p. 1175, LESS. Synop. Comp. p. 155 ; DC. Prodr. V, p. 108 ; MIQ. Fl. Ind. Bat. II, p. 23 ; HOOKER, Niger Fl. p. 430 ; BENTH. Fl. Hongk. p. 171 ; SONDER, Fl. Capens. III, p. 57 ; BENTH. Fl. Austral. III, p. 462 ; GRISEBACH, Fl. Brit. West Ind. Isl. p. 356 ; SEEMANN, Fl. Viti. p. 140 ; CLARKE, Comp. Ind. p. 30 ; OLIVER, Fl. Tropic. Africa, III, p. 300 ; HEMSL. Voy. Chall. Bot. I, p. 40, et part 3, p. 159 ; et in Biol. Central.-Americ. II, p. 81 ; A. GRAY, Synop. Fl. N. Americ. ed-2, I, part 2, p. 93 ; HILLEBRAND, Fl. Hawai. Isl. p. 193 ; HOOK. f. Fl. Brit. Ind. III, p. 243 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 403 ; HENRY, List Pl. Forms. p. 51.

Hab. Taipea, leg. T. MAKINO, anno 1896, et C. OWATARI, anno 1897.

DISTRIB. In calidis regionibus universaliter dispersa.

## 5. *Eupatorium* LINN.

### *Conspetus Specierum.*

Caulis erectus.

Folia non partita.

Folia saepissime ovata. Involueri bractee obtusae.

Folia basi rotundata. ....1. *E. Reevesii*.

Folia basi angustata. ....2. *E. japonicum*.

Folia oblongo-lanceolata. Involueri bractee acutae. 3. *E. Lindleyanum*.

Folia tri-partita. ....4. *E. Chinense*-var. *tripartitum*.

Caulis scandens. ....5. *E. Tashiroi*.

**1. *E. Reevesii*** WALL.; DC. Prodr. V, p. 179; HOOK. et ARN. Bot. Beech. Voy. p. 267; BENTH. Fl. Hongk. p. 172; CLARKE, Comp. Ind. p. 33; HOOK. f. Fl. Brit. Ind. III, p. 243; FORB. et HEMSL. Ind. Fl. Sin. I, p. 405; HENRY, List Pl. Formos. p. 51.

Hab. Loco non indicato.

DISTRIB. China et Japonia.

**2. *E. japonicum*** THUNB. Fl. Jap. p. 308; DC. Prodr. V, p. 180; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 181; MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 167; FRANCH. et SAV. Enum. Pl. Jap. I, p. 219; FRANCH. Pl. David. p. 160; MAXIM. in Engl. Jahrb. VI, p. 68; FORB. et HEMSL. Ind. Fl. Sin. I, p. 403; HENRY, List Pl. Formos. p. 51; DIELS, Fl. Cent. China, in Engl. Jahrb. XXIX, p. 608.

*Eupatorium Wallichii* DC. Prodr. V, p. 179; BENTH. Fl. Hongk. p. 172; HANCE in Journ. Linn. Soc. XIII, p. 106.

Jap. Icon. Somokudzusetz, vol. 15, fol. 56; Honzodzufu, vol. 11, fol. 14 recto. kwa-wi, herb., vol. 3, fol. 14.

Hab. Daitocho: Daikako, leg. K. MIYAKE, anno 1899.

DISTRIB. Japonia, China, et montosis Indiae borealis regionibus.



**3. *E. Lindleyanum*** DC. Prodr. V, p. 180; BENTH., Fl. Hongk. p. 172, et Fl. Austral. III, p. 462; FORB. et HEMSL. Ind. Fl. Sin. I, p. 404; HENRY, List Pl. Formosa, p. 52; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 608.

Hab. Shinteku, leg. T. MAKINO, anno 1896; Biyo-ritsu, leg. K. HONDA, anno 1897; Senton, ipe, anno 1900.

DISTRIB. Mandshuria, Japonia et Australia.

**4. *E. chinense*** var. tripartitum MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 167; FORB. et HEMSL. Ind. Fl. Sin. I, p. 405.

Hab. Taipea, Tamsui, Kierung, leg. T. MAKINO, anno 1896; Kuchu, Shintemkoe, leg. K. MIYAKE, anno 1899.

**5. *E. Tashiroi*** HAYATA, sp. nov. cum tab. I.

Suffrutices; caulis scandens, teres, laevis, ramosus, ramis gracilibus divaricatis. Folia opposita, petiolata, tenuia, glabra, lanceolata, v. ovato-lanceolata, acuminata, basi obtusa v. rotundata, dentata, dentibus ascendentibus, acutis v. mucronatis, 3-nervia, 4-8 cm. longa, 2-3 cm. lata, petiolis brevibus 6-8 mm. longis. Paniculae laxae corymbosae, pedunculis 3-5, remotis, oppositis, 2-4 cm. longis, pedicellis 1-1½ cm. longis, capitulum bis aequantibus, pubescentibus. Capitula 5-flora, 1 cm. longa. Involucrum anguste campanulatum, bracteis elongato-lanceolatis, 1-2-seriatis, siccis, scariosis, interioribus 5, 5 mm. longis, exterioribus 5-6, minoribus, additis 3-4-bracteolis, minimis 1½ mm. longis. Receptaculum minimum convexum, nudum. Corollae 4 mm. longae, tubo tenui, limbo anguste campanulato 5-dentato. Styli rami longissimi, 3 mm. longi corollam valde excedentes, superne compressiusculi. Achaemia glabra, nigra 5-costata, costis prominentibus sub-rugosis, 2½ mm. longa, apice truncata. Pappi setae 1-seriatae  $\infty$ , rigidae, scabrae, 3 mm. longae.

Ab *E. iresinoides* KTH. differt foliis glaberrimis.

Hab. Sharioto, leg. T. MAKINO, anno 1896 ; prope Taito, leg. Y. TASHIRO, anno 1897 ; Kuchu, leg. K. MIYAKE, anno 1899 ; in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899 ; Senton, ipse, anno 1900.

## 6. *Mikania* WILLD.

1. *M. scandens* WILLD. Sp. Pl. III, p. 1743, LESS. Synopsi. Comp. p. 157 ; DC. Prodr. V, p. 199 ; GRISEBACH, Fl. Brit. West Ind. Isl. p. 364 ; CLARKE, Comp. Ind. p. 84 ; OLIVER, Fl. Tropic. Afric. III, p. 301 ; HOOK. f. Fl. Brit. Ind. III, p. 244 ; HEMSL. in Biol. Central-Americ. IV, p. 104 ; A. GRAY Synop. Fl. N. Americ. ed-2, I, part 2, p. 94 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 405 ; HENRY, List Pl. Formos. p. 59.

*Eupatorium scandens* LINN. Sp. Pl. ed-2, p. 1171.

*Mikania volubilis* WILLD. Sp. Pl. III, p. 1743 ; MIQ. Fl. Ind. Bat. II, p. 28.

Hab. Taichu-ken, leg. Y. TASHIRO, anno 1897 ; Botansha, leg. K. MIYAKE, anno 1897.

DISTRIB. In Asia, Africa et America, late diffusa.

## 7. *Solidage* LINN.

1. *S. Virga-aurea* LINN. ; THUNB. Fl. Jap. p. 317 ; WILLD. Sp. Pl. p. 2065 ; LESS. Synop. Comp. p. 163 ; DC. Prodr. V, p. 338 ; BENTH. Fl. Hongk. p. 179 ; SOWERBY, English Bot. (1873) t. 1278 ; FRANCH. et SAV. Enum. Pl. Jap. I, p. 228 ; CLARKE, Comp. Ind. p. 35 ; HOOK. f. Fl. Brit. Ind. III, p. 245 ; K.

MIYABE, Fl. Kuile Isl. in Mem. Bost. Soc. Nat. Hist. IV. (1890) p. 240 ; FORB. et HEMSL. Ind. Fl. Sin I, p. 406 ; HENRY, List Pl. Formos. p. 52 ; A. GRAY, Synop. Fl. N. Americ. ed-2, I, part 2, p. 148.

*S. cantoniensis* et *S. decurrens* LOUR. Fl. Cochinch. 2-ed, p. 612. DC. Prodr. V, pp. 341-2.

Icon-Jap. Somokudsusetz, vol. 17, fol. 40 ; Hondsodsuftu, vol. 14, fol. 15, recto.

Hab. Tamsui, leg T. MAKINO, anno 1896 ; et K. NINAMI anno 1899 ; in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899 ; SA-BO-SAN-SHO, ipse, anno 1900.

DISTRIB. Europea, Asia temperata, Japonia et America borealis.

## 8. *Dichrocephala* DC.

1. *D. latifolia* DC. Prodr. V, p. 372 ; MIQ. Fl. Ind. Bat. II, p. 37 ; WIGHT, Ic. Pl. Ind. or. t. 1096 ; BENTH. Fl. Hongk. p. 173 ; FR. et SAV. Enum. Pl. Jap. I, p. 229 ; SONDER, Fl. Capens. III, p. 115 ; CLARKE, Comp. Ind. p. 36 ; OLIVER, Fl. Tropic. Afric. III, p. 303 ; HOOK. f. Fl. Brit. Ind. III, p. 245 ; MAXIM. in Engl. Jahrb. VI, p. 68 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 306 ; HENRY, List. Pl. Formos. p. 52 ; DIELS, Fl. Central-Chin. in Engl. Jahrb. XXIX, p. 115.

Hab. loco non indicato.

DISTRIB. Asia tropica subtropicave et Africa.

## 9. *Grangea* ADANS.

1. *G. maderaspatana* POIR.; LESS. Synop. Comp. p. 202; DC. Prodr. V, p. 373; MIQ. Fl. Ind. Bat. II, 39; BENTH Fl. Hongk. p. 185; WIGHT, Ic. Pl. Ind. or., t. 1097; CLARK. Comp. Ind. p. 37; OLIVER, Fl. Tropic. Afric. III, p. 304; HOOK. f. Fl. Brit. Ind. III, p. 247; FORB. et HEMSL. Ind. Fl. Sin. I, p. 407; HENRY, List. Pl. Formos. p. 52.

Hab. Hosoon, Sencoreisho, H. KAWAKAMI, anno 1895;  
Tai-chu-ken: Ho-ri-sha, leg. Y. TASHIRO, anno 1897;  
Bo-riyo. Sin-ye-sha, leg. C. Owatari, anno 1898; Tai-  
chu-ken: Daibo-ho-soo, leg. R. SATAKE, anno, 1899.

DISTRIB. Tropica Africa et Asia.

## 10. *Aster* LINN.

### *Conspectus Specierum.*

Folia margine non ciliata.

Folia linearia .....1. *A. altaicus*.

Folia ovata v. ovato-lanceolata.

Pappus copiosus.

Capitula longe pedunculata .....2. *A. trinervius*.

Capitula fere sessilia .....3. *A. baccharoides*.

Pappus .....4. *A. indicus*.

Folia margine duplicato-ciliata .....5. *A. Oldhami*.

1. *A. altaicus* WILLD.; NEES. Gen. et Sp. Aster. p. 228;  
CLARKE, Comp. Ind. p. 46; HOOK. f. Fl. Brit. Ind. III, p. 251;  
FRANCH. Pl. David. p. 161; FORB. et HEMSL. Ind. Fl. Sin. I, p. 408.

*Calimeris altaica* NEES, Gen. et Sp. Aster. p. 228 ; DC. Prodr. V. p. 258.

*Calimeris ciliata* A. GRAY, Bot. Jap. p. 394.

*Aster striatus* FR. et SAV. Enum. Pl. Jap. I, p. 222.

Hab. Manka, leg. T. MAKINO anno 1896 ; Biyo-un, leg.  
Y. TASHIRO, anno 1897 ; Taito-cho : Suibi, Perung,  
Chihou, leg. K. MIYAKE, anno 1899.

DISTRIB. in montibus Altaii, Mandshuria et Japonia.

**2. A. trinervius** ROXB. Fl. Ind. III, p. 433 ; NEES, Gen. et Sp. Ast. p. 173 ; BENTH. Fl. Hongk. p. 174 ; FR. et SAV. Enum. Pl. Jap. I, p. 222 ; HOOK. f. Fl. Brit. Ind. III, p. 252 ; FRANCH. Pl. David. p. 161 ; MAXIM. in Engl. Jahrb. VI, p. 68. FORB. et HEMSL. Ind. Fl. Sin. I, p. 416 ; HENRY, List Pl. Formos. p. 52.

*Diploppapus asperimus* DC. Prodr. V. p. 277 (fide HEMSL.).

*Aster ageratoides* TURCZ ; MAXIM. Pr. Fl. Amur. p. 144.

Icon. Jap. Somokudzusetz, vol. 16, fol. 59.

Hab. Shinteku, leg. T. MAKINO, anno 1896 ; Horisha,  
Suisha, leg. C. OWATARI, anno 1896 ; Daito-cho :  
Dai-koko, Bokusei-kakk. leg. K. MIYAKE, anno  
1899.

DISTRIB. Mandshuria, Japonia, et in montibus Indiae  
borealis orientalisve.

**3. A. baccharoides** STEETZ ; BENTH. Fl. Hongk. p. 75 ;  
FORB. et HEMSL. Ind. Fl. Sin. I, p. 409 ; HENRY, List Pl. Formos.  
p. 52 ; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX. p. 610.

Hab. Shinteku, leg. T. MAKINO, anno 1896.

DISTRIB. Hongkong et China centralis.

**4. *A. indicus*** LINN. Sp. Pl. ed-2, p. 1230. FRANCH. Pl. David, p. 160 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 413 ; HENRY, List Pl. Formos. p. 52 ; DIELS, Fl. Central-China, in Engl. Jahrb. XXIX, p. 609.

*Boltnia indica* BENTH. Fl. Hongk. p. 174 ; HANCE in Journ. Linn. Soc. XIII, p. 106 ; FRANCH. et SAV. Enum. Pl. Jap. I, p. 225 ; CLARK. Comp. Ind. p. 40 ; HOOK. f. Fl. Brit. Ind. III, p. 249.

*Hsutsua serrata* HOOK. et Arn. Bot. Beech. Voy. p. 265 ; fide HEMSL.

Icon. Jap. Somokudzusetz, vol. 16, fol. 51.

Hab. Kierung, Taipea, leg. T. MAKINO, anno 1896 ;  
Pachina, leg. T. NINAMI, anno 1897 ; Sabo-sansho,  
ipse, anno 1900.

DISTRIB. in India or., China cent., et Japonia.

**5. *A. Oldhami*** HEMSL. Forb. et HEMSL. Ind. Fl. Sin. I, p. 414 ; HENRY, List Pl. Formos. p. 52.

Hab. Senton, ipse, anno 1900.

DISTRIB. Planta endemica.

## 11. *Erigeron* LINN.

**1. *E. linifolius*** WILLD. Sp. Pl. III, p. 1955 ; BENTH. Fl. Hongk. p. 176, et Fl. Austr. III, p. 496 ; CLARKE, Comp. Ind. p. 50 ; HEMSL. Voy. Chall. Bot. I, part I, p. 42 ; A. GRAY, Synop. Fl. N. Americ. ed-2, I, part 2, p. 220 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 418 ; HENRY, List Pl. Formos. p. 52 ; DIELS, Fl. Central-China, in Engl. Bot. Jahrb. XXIX, p. 612.

*Congza ambigua* DC. Prodr. V. p. 381.



Hab. Taipea, leg. T. MAKINO, anno 1896.

DISTRIB. Indiges Mediterraneae regionis, nunc late collocatus.

## 12. *Conyza* LESS.

### *Conspectus Specierum.*

Folia oblongo-ovata. ....1. *C. japonica*.

Folia lanceolata pinnatifida. ....2. *C. aegyptica*.

**1. *C. japonica*** LESS.; DC. Prodr. V, p. 382 ; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 184 ; FR. et SAV. Enum. Pl. Jap. I, p. 229 ; CLARKE, Comp. Ind. p. 63 ; HOOK. f. Fl. Brit. Ind. III, p. 258 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 419 ; HENRY, List Pl. Formos. p. 52 ; DIELS, Fl. Centr.-Chin. in Engl. Jahrb. XXIX, p. 612.

*Conyza vernonicaefolia* WALL. DC. Prodr. V. p. 382 ; BENTH. Fl. Hongk. p. 176.

Hab. Loco non indicato.

DISTRIB. Japonia, China centralis, India borealis.

**2. *C. aegyptica*** AIT. Hort. Kew. ed-2, V, p. 28 ; DC. Prodr. V, p. 382 ; BENTH. Fl. Austral. III, p. 497 ; OLIVER Fl. Tropic. Afric. III, p. 314 ; HANCE, in Journ. Bot. (1878), p. 108 ; HOOK. f. Fl. Brit. Ind. III, p. 258 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 419 ; HENRY, List. Pl. Formos. p. 52.

Hab. Sinteku, leg. T. MAKINO, anno 1896. Kotosho, leg.

Y. TASHIRO, anno 1897 ; Taichu-Ken : prope Te-run-

gai, leg. Y. TASHIRO, anno 1897.

DISTRIB. Tropica Asia, Africa, et Australia.

### 13. *Microglossa* DC.

1. *M. volubilis* DC. Prodr. V. p. 320; MIQ. Fl. Ind. Bat. II, p. 34; CLARKE, Comp. Ind. p. 57; OLIVER, Fl. Tropic. Afric. III, p. 309; HOOK. f. Fl. Brit. Ind. III, p. 257; FORB. et HEMSL. Ind. Fl. Sin. I, p. 419; HENRY, List Pl. Formos. p. 52.

*Erigeron pyrifolius* BENTH. Fl. Hongk. p. 176.

Hab. Daibo-ho-sho, leg. R. SATAKE, anno 1899.

DISTRIB. India or. et Malaya, tropic. Africa.

### 14. *Xanthium* LINN.

1. *X. Strumarium* LINN. Sp. Pl. ed-2, p. 1400; LOUR. Fl. Cochinch. ed-2, p. 689; LESS. Synop. Comp. p. 219; DC. Prodr. V. p. 523; BENTH. Fl. Hongk. p. 181; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 185; SOWERBY, Engl. Bot. t. 1360; FR. et SAV. Enum. Pl. Jap. I, p. 231; CLARKE, Comp. Ind. 132; OLIVER, Fl. Tropic. Afric. III, p. 371; HOOK. f. Fl. Brit. Ind. III, p. 303; FRANCH. Pl. David. p. 164; HILLEBRAND, Fl. Hawai. Isl. p. 202; A. GRAY, Synop. Fl. N. Americ. ed-2, I, part 2, p. 252; FORB. et HEMSL. Ind. Fl. Sin. I, p. 433; HENRY, List Pl. Formos. p. 54; DIELS, Fl. Centr. China in Engl. Jahrb. XXIX, p. 615.

*Xanthium indicum* KÖNIG.; ROX. Fl. Ind. III, p. 601; DC. Prodr. V. p. 523; MIQ. Fl. Ind. Bat. II, p. 68.

Icon. Jap. Somokudsusetz, vol. 20, fol. 25; Hondsodsnufu, vol. 16, fol. 4, verso.

Hab. Taipea, leg. T. MAKINO, anno 1896; Gishun, leg. Y. TASHIRO, anno 1898.

DISTRIB. In regionibus calidis vulgaris.

## 15. *Siegesbeckia* LINN.

1. *S. orientalis* LINN. Sp. Pl. ed-2, p. 1269 ; ROXB. Fl. Ind. III, p. 439 ; LOUR. Fl. Cochinch. ed-2, p. 616 ; LESS. Synop. Comp. p. 211 ; DC. Prodr. V, p. 495 ; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 185 ; MIQ. Fl. Ind. Bat. II, p. 67 ; BENTH. Fl. Hongk. p. 182. et Fl. Austral. III, p. 535 ; SONDER, Fl. Capens, III, p. 132 ; SEEMANN, Fl. Vit. p. 142 ; FR. et SAV. Enum. Pl. Jap. I, p. 231 ; CLARKE, Comp. Ind. p. 133 ; OLIVER, Fl. Tropic. Afric. III, p. 372 ; Hook. f. Fl. Brit. Ind. III, p. 304 ; HEMSL. in Biol. Centr.-Americ. IV, p. 157 ; FRANCH. Pl. DAVID. p. 164 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 433 ; HILLEBRAND, Fl. Hawai. Isl. p. 204 ; HENRY, List Pl. Formos. p. 54 ; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 615.

Icon. Jap. Kwawi, herb., vol. 3, fol. 9 ; Somokudzusetz vol. 16, fol. 31, Hondsodsufu, vol. 16, fol. 7, verso.

Hab. Taipea, Leg. T. MAKINO, anno 1896 ; Pachina, leg. T. NINAMI et UENO, anno 1897 ; Kōtōsho, leg. K. MIYAKE, anno 1899 ; in montibus Morrison 5000 ped. alt. leg. R. TORII, anno 1899.

DISTRIB. In calidis regionibus et temperatis, universale dispersa.

## 16. *Eclipta* LINN.

1. *E. alba* HASSK. ; MIQ. Fl. Ind. Bat. II, p. 65 ; BENTH. Fl. Hongk. p. 181 ; et Fl. Austral. III, p. 536 ; GRISEBACH, Fl. West. Ind. Isl. p. 370 ; FR. et SAV. Enum. Pl. Jap. I, p. 235 ; CLARKE, Comp. Ind. p. 134 ; OLIVER, Fl. Tropic. Africa III, p. 373 ;

HOOK. f. Fl. Brit. Ind. III, p. 304; FRANCH. Pl. David. p. 165; A. GRAY, Synop. Fl. N. Americ. ed-2, I, part 2, p. 256; MAXIM. in Engl. Jahrb. VI, p. 68; FORB. et HEMSL. Ind. Fl. Sin. I, p. 433; HILLEBRAND, Fl. Hawai. Isl. p. 203; HENRY, List Pl. Formos. p. 54; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 616.

*Eclipta erecta* LINN., et *E. prostrata* DC. Prodr V, p. 490.

Icon. Jap. Somokudsusetz, vol. 17, fol. 45; Hondsofsufu, vol. 19, fol. 11, recto.

Hab. Kierung, Taiepa, leg. T. MAKINO, anno 1896; et leg. C. OWATARI anno 1897. Toko-boryo, leg. C. OWATARI, anno 1898; Kuchu, Shinten-gai, leg. K. MIYAKE, anno 1899; et leg. T. NINAMI, Kierung, ipse, anno 1900.

DISTRIB. In tropicis et subtropicis regionibus generalliter dispersa.

## 17. *Wedelia* JACQ.

### *Conspectus Specierum.*

Capitula solitaria.

Folia oblonga utrinque pauci sub-3-dentata, basi cuneata .....

1. *W. prostrata*.

Folia oblongo-lanceolata attenuata subintegra .....

2. *W. calendulacea*.

Capitula 2, 3, v. 4, laxe corymbosa ..... 3. *W. biflora*.

1. *W. prostrata* HEMSL. in FORB. et HEMSL. Ind. Fl. Sin. I, p. 434; HENRY, List Pl. Formos. p. 54.

*Wollastonia prostrata* HOOK. et ARN. Bot. Beech. Voy. p. 265.

*Verbesina prostrata* HOOK. et ARN. Bot. Beech. Voy. p. 195.

Hab. Chuko, leg. K. HONDA, anno 1897.

DISTRIB. Japonia, China australis.

**2. *W. calendulacea*** LESS. Synops. Comp. p. 222 ; DC. Prodr. V. p. 539 ; MIQ. Fl. Ind. Bot. II, p. 68 ; WIGHT, Ic. Pl. Ind. or. t. 1107 ; BENTH. Fl. Hongk. p. 182 ; et Fl. Austral. III, p. 537 ; FRANCH. et SAV. Enum. Pl. Jap. I, 233 ; CLARKE, Comp. Ind. p. 136 ; MAXIM. in Engl. Jahrb. VI, p. 68 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 434 ; HENRY, List. Pl. Formos. p. 54.

*Verbesina calendulacea* LINN; LOUR. Fl. Cochinch. ed-2, p. 619 ; HOOK. et ARN. Bot. Beech. p. 265.

Ic. Jap. So-mokudzusetz vol. 17, fol. 36.

Hab. Sensoreisho, leg. H. KAWAKAMI, anno 1895 ; Keirung leg. T. MAKINO anno 1896 ; Biyo-zoku, leg. K. HONDA, anno 1897 ; Pachina, leg. T. NINAMI, anno 1899 ; Prope dai-to, Kwarenko, leg. K. MIYAKE, anno 1899 ; Senton, ipse, anno 1900.

DISTRIB. In tropica Asia late dispersa.

**3. *W. biflora*** BENTH. Fl. Hongk. p. 183 ; et Fl. Austral. III, p. 539 ; CLARKE, Comp. Ind. p. 137 ; OLIVER, Fl. Tropic. Afric. III, p. 376 ; HOOK. f. Fl. Brit. Ind. III, p. 306 ; HANCE, in Journ. Linn. Soc XIII, p. 108 ; HEMSL. Voy. Chall. Bot. I, part 3, pp. 160, et 241 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 433 ; HENRY, List. Pl. Formos. p. 54.

*Wollastonia biflora* DC. Prodr. V, p. 546. MIQ. Fl. Ind. Bat. II, p. 70.

Hab. Ho-soan, Shinshoa, leg. H. KAWAKAMI, anno 1896.  
Biyo-ritsu, leg. K. HONDA, anno 1897, Shario-to, leg.

T. MAKINO, anno 1896 ; et K. MIYAKE, anno 1899 ;  
 Daito-cho : Biyoko-sha, leg. K. MIYAKE, anno 1899 ;  
 Kierung, ipse, anno 1900.

DISTRIB. in maritimis regionibus Indiae et Malayæ.

## 18. *Spilanthes* LINN.

1. **S. *Acmella*** LINN. ; THUNB. Fl. Jap. p. 321 ; DC. Prodr. V. p. 623 ; MIQ. Fl. Ind. Bat. II, p. 79 ; CLARKE, Comp. Ind. p. 138 ; OLIVER, Fl. Tropic. Afric. III, p. 384 ; HOOK. f. Fl. Brit. Ind. III, p. 207 ; HENRY, List Pl. Formos. p. 54.

Hab. Taichu-ken : Chigito, leg. Y. TASHIRO, anno 1897 ;

Daito : Raiko-kwa, leg. K. MIYAKE, anno 1899.

DISTRIB. generalliter in calidis regionibus.

## 19. *Bidens* LINN.

### *Conspectus Specierum.*

Flos albus .....	1. <i>B. pilosa</i> .
Flos flavus .....	2. <i>B. bipinnata</i> .

1. **B. *pilosa*** LINN. Sp. Pl. ed-2, p. 1166 ; THUNB. Fl. Jap. p. 307 ; LOUR. Fl. Cochinch. p. 596 ; DC. Prodr. V, p. 597 ; HOOK. Niger Fl. p. 435 ; MIQ. Fl. Ind. Bat. II, p. 76 ; BENTH. Fl. Hongk. p. 183 ; et Fl. Austral. III, p. 543 ; SONDER, Fl. Capens. III, p. 133 ; CLARKE, Comp. Ind. p. 140 ; HOOK. Handb. Newzeal. Fl. p. 138 ; OLIVER, Fl. Tropic. Afric. III, p. 393 ; HEMSLE. Voy. Chall. Bot. I, part, 1, p. 45 ; et part 3, p. 161. et in Biol. Centr.-Americ. IV, p. 103, et II, p. 203 ; SEEMANN, Fl. Vit. p. 143 ; A. GRAY, Synop. Fl. N. Americ. ed-2, I, part 2, p. 297 ;



MAXIM. in Engl. Jahrb. VI, p. 68 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 435 ; HILLEBRAND, Fl. Hawai. p. 217 ; HENRY, List Pl. Formos. p. 54 ; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 616.

*Bidens chinensis* WILLD. Sp. Pl. III, p. 1719.

*Glossogyne chinensis* LESS. Synop. Comp. p. 212.

*Bidens lanceolata* WILLD. Sp. Pl. III, p. 1719.

Icon. Jap. Somokudsusetz, vol. 15, fol. 60 ; Hondsodsufu vol. 20, fol. 22, verso.

Hab. Taipea, leg. T. MAKINO, anno 1896 ; et leg. C. OWATARI, anno 1897 ; prope Botansha, Kei-bi. Shinkogai, leg. K. MIYAKE, anno 1899.

DISTRIB. In tropicis regionibus late diffusa, interdum in temperatis regionibus.

**2. B. bipinnata** LINN. Sp. Pl. ed-2, p. 1166 ; ROXB. Fl. Ind. III, p. 411. LOUR. Fl. Cochinch. ed-2, p. 596 ; DC. Prodr. V, p. 603 ; HOOKER, Niger Fl. p. 142 ; BENTH. Fl. Hongk. p. 183 ; et Fl. Austral. III, p. 543 ; GRISEBACH, Fl. West. Ind. Isl. p. 373 ; CLARKE, Comp. Ind. p. 140 ; OLIVER, Fl. tropic. Afric. III, p. 393 ; HEMSL. in Biol. Centr.-Americ. II, p. 201 ; FRANCH. Pl. David. p. 165 ; A. GRAY, Fl. Synop. Fl. N. Americ. ed-2, I, part 2, p. 297 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 434 ; HENRY, List Pl. Formos. p. 54 ; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 616.

*Bidens Wallichii* DC. Prodr. V, p. 598 ; MIQ. Fl. Ind. Bat. II, p. 77.

*Bidens pilosa* var. *bipinnata* Hook. f. Fl. Brit. Ind. III, p. 309.

Icon. Jap. Somokudsusetz, vol. 15, fol. 61.

Hab. Taipea, leg. T. MAKINO, anno 1896 ; Pachina, leg. T.

NIINAMI, anno 1897 ; Senton, ispe, anno 1900.

DISTRIB. In calidis regionibus late diffusa.

## 20. *Glossogyne* CASS.

1. *G. tenuifolia* CASS.; LESS. Synop. Comp. p. 212; DC. Prodr. V, p. 632; MIQ. Fl. Ind. Bat. II, p. 83; BENTH. Fl. Hongk. p. 184; et Fl. Austral. III, p. 544; SEEMANN, Fl. Vit. p. 144; FORB. et HEMSL. Ind. Fl. Sin. I, p. 436; HENRY, List Pl. Formos. p. 54.

Hab. Shintek, leg. T. MAKINO, anno 1896; Chu-kō, leg. K.

HONDA, anno 1897.

DISTRIB. Australia, Nova-Caledonia, et insulis Philippinis.

## 21. *Tagetes* LINN.

1. *T. patula* LINN. Sp. Pl. ed-2, p. 1249; THUNB. Fl. Jap. p. 320; ROXB. Fl. Ind. III, p. 434; LOUR. Cochinch. ed-2, p. 616; LESS. Synop. Comp. p. 236; MIQ. Fl. Ind. Bat. II, p. 84; DC. Prodr. V, p. 643; HOOKER, Niger Fl. p. 142; CLARKE, Comp. Ind. p. 142; HENRY, List Pl. Formos. p. 54.

Hab. Tainan: prope Botan-sha, leg. K. MIYAKE, anno 1899.

DISTRIB. Indiges in Mexico, nunc in hortis totius fere orbis cultus.

## 22. *Chrysanthemum* LESS.

1. *C. Segetum* LINN. Sp. Pl. ed.-2, p. 1255; DC. Prodr. VI, p. 64; FORB. et HEMSL. Ind. Fl. Sin. I, p. 438; HENRY, List Pl. Formos. p. 54.

Hab. Taipea, (cult.) S. NAGASAWA, anno 1902.

DISTRIB. In Japonia culta.

## 23. *Myriogyne* LESS.

1. *M. minuta* LESS. in Linnaea VI, p. 219; DC. Prodr. VI, p.

139; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 187; BENTH. Fl. Hongk. p. 186; et Fl. Austral. III, p. 553; SEEMANN, Fl. Vit. p. 144; FR. et SAV. Enum. Pl. Jap. I, p. 241; CLARKE, Comp. Ind. p. 151; FORB. et HEMSL. Ind. Fl. Sin. I, p. 440; HENRY, List Pl. Formos. p. 54.

*Centipeda orbicularis* LOUR. Fl. Cochinch. ed-2, p. 602; MIQ. Fl. Ind. Bat. II, p. 89; FRANCH. Pl. David. p. 167.

*Sphaeromorphaca Centipeda* DC. VI, p. 140.

Jap. Icon. Somokudsusetz. vol. 16, fol. 29.

Hab. Sensoreisho, Naihosha, leg. H. KAWAKAMI, anno 1895;  
Kierung, leg. T. MAKINO, anno 1896; Shu-shu-gai,  
Rinpoho, leg. C. OWATARI, anno 1898. et leg. T.  
NINAMI, anno 1899.

DISTRIB. India, Malaya, Australia et Japonia.

## 24. *Artemisia* L.

### *Conspectus Specierum.*

Folia capillaria .....1. *A. capillaris*.

Folia profunde pinnatifida .....2. *A. vulgaris* var. *indica*.

**1. *A. capillaris*** THUNB. Fl. Jap. p. 309; DC. Prodr. VI, p. 126; MAXIM. in Mém. Biol. VIII, p. 524; FR. et SAV. Enum. Fl. Jap. I, p. 239; FORB. et HEMSL. Ind. Fl. Sin. I, p. 442; HENRY, List Pl. Formos. p. 54.

Icon. Jap. Somokudsusetz, vol. 16, 28; Hondsodzufu vol. 14, fol. 2, rect.

Hab. Pikaku, leg. T. MAKINO, anno 1896. Daitocho:  
Pinnang, Lo-ko-tzun, Kuchu, Shintenkoé, leg. K.  
MIYAKE, anno 1899.

DISTRIB. Mandshuria, Kamtschatka, et Japonia.

**2. *A. vulgaris* L. var. *indica* MAXIM.** Prim Fl. Amur. p. 536 ; FR. et SAV. Enum. Pl. Jap. I, p. 259.

*A. indica* WILLD. Sp. Pl. III, p. 1846 ; DC. Prodr. VI, p. 114.

Hab. Taipea, Tamsui, Sintekku, leg. T. MAKINO, anno 1896 ;  
Funsui, leg. K. HONDA, anno 1897 ; Keiteisio, ipse  
anno 1900.

DISTRIB. Europea occidentalis, Kamtschatka, Japonia et  
Malaya archipelago.

## 25. *Crossostephium* LESS.

**1. *C. artemisoides* LESS.** in Linnaea VI, p. 220 ; DC. Prodr. VI, p. 127 ; MIQ. Fl. Ind. Bat. II, p. 89 ; MAXIM. in Mém. Biol. VIII, p. 520 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 440 ; HENRY, List Pl. Formos. p. 55.

*Tanacetum chinense* A. GRAY, ex MAXIM.

Hab. Hō-soan, leg. H. KAWAKAMI, anno 1895 ; Shinteku, leg.  
T. MAKINO, anno 1896 ; Kōtoshō, leg. K. MIYAKE,  
anno 1899.

DISTRIB. In insulis Philippinis, Loo-choo, et India culta.

## 26. *Gynura* CASS.

### *Conspectus Specierum.*

Folia omnia subradicalia, obovata, attenuata, grosse 2-3-dentata,  
dentibus obtusis .....1. *G. ovalis*.

Folia omnia caulina, elliptica v. ovato-lanceolata, subintegra v.  
dentata, dentibus acutis.

Folia ovato-lanceolata, dentata .....2. *G. bicolor*.  
 Folia elliptica, remote serrata v. subintegra .....3. *G. elliptica*.

**1. *G. ovalis*** DC. Prodr. VI, p. 300; FORB. et HEMSL. Ind. Fl. Sin. I, p. 448; HENRY, List Pl. Formos. p. 55.

*Cacalia bulbosa* LOUR. Fl. Cochinch. ed-2, p. 592.

*Gynura auriculata* DC. Prodr. VI, p. 300, fide Benth.

*Gynura Pseudochina* DC. Prodr. VI, p. 299; MIQ. Fl. Ind. Bat. II, p. 100; BENTH. Fl. Hongk. p. 189; HOOK. f. Fl. Brit. Ind. III, p. 335.

*Gynura bulbosa* HOOK. et ARN. Bot. Beech. Voy. p. 194; DC. Prodr. VI, p. 301.

Hab. Sha-ryo-to, leg. T. MAKINO, anno 1596; Gishun,

Garanbice, leg. Y. TASHIRO, anno 1897; Daito-cho:

Biyo-ko-sha, leg. K. MIYAKE, anno 1899.

DISTRIB. in China et India.

**2. *G. bicolor*** DC. Prodr. VI, p. 299; MIQ. Fl. Ind. Bat. II, p. 99; HOOK. f. Fl. Brit. Ind. III, p. 335; FORB. et HEMSL. Ind. Fl. Sin. I, p. 447; HENRY, List Pl. Formos. p. 55.

Hab. Kwatana, leg. H. KAWAKAMI, anno 1895; Taiko, leg.

C. OWATARI, anno 1897; Daito: prope Kwarenko,

Rai-ko-kwa, leg. K. MIYAKE, anno 1899.

DISTRIB. Molucca et Japonia.

**3. *G. elliptica*** YABE et HAYATA, cum tab. II.

Herba; caulis glaber, striatus, erectus, crassiusculus. Folia magna, petiolata, elliptica, v. ovato-elliptica, apice acuta v. obtusa, basi leviter attenuata, subintegra, v. remote serrata, 5-8 cm. longa, petiolis 2 cm. longis, auriculis, distinctis, majusculis, grosse pauci-dentatis, pinninervia, costis secundariis utroque latere 5-6. Corymbus laxus, 5-6-cephalus,

pedicellis brevibus  $\frac{1}{2}$ – $1\frac{1}{2}$  cm. longis. Capitula homogama cylindrico-campanulata,  $1\frac{1}{3}$  cm. longa, floribus omnibus  $\tilde{\sigma}$  fertilibus. Involucrum sub-campanulatum, bracteis sub-2-seriatis, interioribus 12–13-phyllis, lineari-lanceolatis, acutis, apice margineque scariosis, 1 cm. longis, aequalibus, plus minus cohaerentibus, additis exterioribus parvis  $\frac{1}{2}$  cm. longis. Receptaculum planum breviter fimbriiferum. Corollae flavae tenuiter tubulosae limbo parum ampliato apice breviter 5-fido. Antherae basi integrae. Styli rami tenues, in appendices longas subulatas hirtellas desinentes. Achaenia angusta, 10-striata. Pappi setae copiosae, 2-seriatae, interioribus longioribus, tenues, albae.

A. G. ovalis DC. pedicellis brevibus, foliis subintegris, facile distincta. Ceteris partibus vero utraque species persimilis.

Hab. Kotosho, leg. K. MIYAKE, anno 1899.

DISTRIB. Planta indigena.

## 27. Emilia CASS.

1. **E. sonchifolia** DC. Prodr. VI, p. 302; MIQ. Fl. Ind. Bat. II, p. 101; HOOKER, Fl. Niger p. 439; GRISEBACH, Fl. Brit. West Ind. Isl. p. 381; FR. et SAV. Enum. Pl. Jap. I, p. 245; CLARKE, Comp. Ind. p. 174; OLIVER, Fl. Tropic. Afric. III, p. 405; HEMSL. Voy. Chall. Bot. I, part 3, p. 161; MAXIM. in Engl. Jahrb. VI, p. 69; FORB. et HEMSL. Ind. Fl. Sin I, p. 449; HENRY, List Pl. Formos. p. 55; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 619.

Hab. Sensoreisho, leg. K. KAWAKAMI, anno 1895; Tamsui, Taipei, leg. T. MAKINO, anno 1896; Senton, ipe, anno 1900.

DISTRIB. In calidis partibus Asiae, Africae, Japonia, et America introducta.



28. *Senecio* L.*Conspectus Specierum.*

Folia non palmatifida.

Folia oblongo-obovata serrata .....1. *S. campestris*.Folia orbicularia grosse dentata .....2. *S. Kaempferi*.Folia lanceolata denticulato-serrulata .....3. *S. nemorensis* L.  
*var octoglossus*.Folia palmatifida .....4. *S. Krameri*.

**1. *S. campestris*** DC. Prodr. VI, p. 361; MAXIM. in Mém. Biol. VIII, p. 15; LEDEB. Fl. Ross. II, p. 646; FR. et SAV. Enum. Pl. Jap. I, p. 251; FRANCH. Pl. David. p. 174; BAKER et MOORE, in Journ. Linn. Soc. XVII, p. 383; FORB. et HEMSL. Ind. Fl. Sin. I, p. 450; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 620.

*Senecio Pierotii* MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 182.

Jap. Icon. Somokudsusetz, XVII, fol. 10.

Hab. Taichu-ken: Taiko, leg. Y. TASHIRO, anno 1897.

DISTRIB. Europea occidentalis, Siberia et Japonia.

**2. *S. Kaempferi*** DC. Prodr. VI, p. 363; MAXIM. in Mém. Biol. VIII, p. 14; FR. et SAV. Enum. Pl. Jap. I, 247; MAXIM. in Engl. Jahrb. VI, p. 69; FORB. et HEMSL. Ind. Fl. Sin. I, p. 454; HENRY, List. Pl. Formos. p. 55.

*Parfugium Kaempferi* BENTH. Fl. Hongk. p. 191.

*Ligularia Kaempferi* SIEB. et ZUCC. Fl. Jap. I, p. 77, t. 35 et 36; Bot. Mag. t. 5302.

*Ligularia gigantea* SIEB. et ZUCC. Fl. Jap. I, p. 79, t. 36.

Jap. Icon. Somokudsusetz, XVII, fol. 27, Hondsodsuifu, XVIII, fol. 8 et 9.

Hab. Kierung, leg. T. MAKINO, anno 1896; et leg. C. OWATARI, anno 1896; Ku-choo, Shinten-koe, Perung, Taito, Keibi, Shinko-Kue, leg. K. MIYAKE, anno 1899; in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899; Taichuken: Taiko, leg. Y. TASHIRO, anno 1897.

DISTRIB. Japonia, Mandshuria.

**3. *S. nemorensis* L. var. *octoglossus* LEDEB.** Fl. Ross. II, p. 641.

*S. octoglossus* DC. Prodr. VI, p. 354.

Hab. in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899.

DISTRIB. in Siberia, Germania et Japonia.

**4. *S. Krameri* FR et SAV.** Enum. Pl. Jap. I, p. 248.

Jap. Icon. Ssmokulsusetz. XVI, fol. 11; Hondzodsufu, vol. 8, fol. 14.

Hab. Biyo-soku, leg. Y. TASHIRO.

DISTRIB. Japonia.

## 29. *Blumea* DC.

### *Conspectus Specierum.*

○ Capitula parva,  $\frac{3}{4}$  cm.— $\frac{1}{2}$  cm. in diametro aequantia, dense paniculato-corymbosa, saepe in glomerulos contractos disposita.

□ Pappus albus.

△ Folia glabrata .....1. *B. membranacea*.

△△ Folia villosa v. sericea

† Capitula in paniculas spiciformes dense disposita .....2. *B. lucera*.

†† Capitula in glomerulas axillares disposita.....

3. *B. sericans*.

□□ Pappus rufus .....4. *B. balsamifera*.

○○ Capitula magna, 1 cm.—1½ cm. in diametro aequantia, laxè paniculato-corymbosa.

□ Pappus albus.

△ Caulis scandens .....5. *B. chinensis*.

△△ Caulis flexuosus .....6. *B. malabarica*.

□ Pappus rufus .....7. *B. spectabilis*.

**1. *B. membranacea*** DC. Prodr. V, p. 440; Hook. f. Fl. Brit. Ind. III, p. 265; HENRY, List. Pl. Form. p. 52.

*Conyza diffusa* ROXB. Fl. Ind. III, p. 429, fide Hook. f.

Hab. Niki, Suichorū, leg. C. OWATARI, anno 1898; Kotosho, prope Gishun, leg. K. MIYAKE, anno 1899.

DISTRIB. Malaya Peninsula.

**2. *B. lacera*** DC. Prodr. V, p. 436; BENTH. Fl. Hongk. p. 178; Hook. f. Fl. Brit. Ind. III, p. 263; FORB. et HEMSL. Ind. Fl. Sin. I, p. 21; HENRY, List. Pl. Formos. p. 52.

Hab. Hōsoan, leg. H. KAWAKAMI, anno 1895. Píkaku, leg. T. MAKINO, anno 1896; Daito: Perung.

DISTRIB. Asia tropica, Africa, et Australia.

**3. *B. sericans*** Hook. f. Fl. Brit. Ind. III, p. 262; FORB. et HEMSL. Ind. Fl. Sin. I, p. 422; HENRY, List. Pl. Formos. p. 53.

Hab. Shinteku, Taipe, leg. T. MAKINO, anno 1896; Ku-chu, Shintem-Kúe, Koto-sho, leg. K. MIYAKE, anno 1899; Hōsoang, leg. Y. TASHIRO, anno 1897; Senton, ipse, anno 1900.

DISTRIB. India.

**4. *B. balsamifera*** DC. Prodr. V, p. 447 ; CLARKE, Comp. Ind. p. 89 ; HOOK. f. Fl. Brit. Ind. III, p. 270 ; HEMSL. Chall. Voy. Bot. I, part 3, p. 160 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 420 ; HENRY, List Formos. p. 52.

*Conyza balsamifera* LINN. Sp. Pl. ed-2, p. 1208 ; MIQ. Fl. Ind. Bat. II, p. 55.

*Baccharis Salvia* LOUR. Fl. Cochinch. ed-2, p. 603.

Hab. Hori-sha, leg. Y. TASHIRO, anno 1897.

DISTRIB. Tropica India et Malaya.

**5. *B. chinensis*** DC. Prodr. V, p. 444 ; BENTH. Fl. Hongk. p. 177 ; HOOK. f. Fl. Brit. Ind. III, p. 268 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 420 ; HENRY, List Pl. Formos. p. 53.

*Conyza chinensis* LINN. Sp. Pl. ed-2, p. 1208 ; MIQ. Fl. Ind. Bat. II, p. 52.

Hab. Penang, leg. T. MAKINO, anno 1896 ; Pachina, leg. T. NINAMI, anno 1897 ; Taïpe, leg. K. HONDA, anno 1897 ; Taïtocho : Leikokwa, Shintenkue, Shokakuto, leg. K. MIYAKE, anno 1899.

DISTRIB. Java et India orientalis.

**6. *B. malabarica*** HOOK. f. Fl. Brit. Ind. III, p. 267.

Hab. Pekak, leg. T. MAKINO, anno 1896.

DISTRIB. India.

**7. *B. spectabilis*** DC. Prodr. V, p. 445 ; HOOK. f. Fl. Brit. Ind. III, p. 269 ; CLARKE, Comp. Ind. p. 96.

Hab. Loco non indicato.

DISTRIB. India.

### 30. *Pluchea* CASS.

1. *P. indica* LESS. in *Linnaea* VI. p. 150; et *Synop. Comp.* p. 207; DC. *Prodr.* V, p. 451; BENTH. *Fl. Hongk.* p. 179; et *Fl. Austral.* III, p. 527; CLARKE, *Composit. Ind.* p. 93; HEMSL. *Voy. Chall. Bot.* I, part 3, p. 160; HOOK. f. *Fl. Brit. Ind.* III, p. 272; FORB. et HEMSL. *Ind. Fl. Sin.* I. p. 422; HENRY, *List Pl. Formos.* p. 53.

Hab. Oshosan, Hōsan, leg. Y. TASHIRO, anno 1896.

DISTRIB. India et Malaya.

### 31. *Gnaphalium* LINN.

#### *Conspectus Specierum.*

Capitula cymula glomerula ad apices ramorum sessilia.

Caulis superne corymbose ramosus, foliosus.

Capitula flava .....1. *G. multiceps.*

Capitula flavo-alba .....2. *G. luteo-album.*

Caulis simplex, superne nudus, scapiformis.....

3. *G. japonicum.*

Capitula in spicam interruptam simplicem aggregata...4. *G. indicum.*

1. *G. multiceps* WALL.; DC. *Prodr.* VI. p. 222; BENTH. *Fl. Hongk.* p. 188; FR. et SAV. *Enum. Pl. Jap.* I, p. 241; FRANCH. *Pl. David.* p. 163; MAXIM. in *Engl. Jahrb.* VI, p. 69; FORB. et HEMSL. *Ind. Fl. Sin.* I. p. 427; HENRY, *List Pl. Formos.* p. 53.

*Gnaphalium luteo-album*, LINN. var. *multiceps* HOOK. f. *Fl. Brit. Ind.* III, p. 288.

*Guaphalium javanum*, *G. ramiserum*, et *G. confusum* DC. Prodr. VI, p. 222.

Icon. Jap. Somokudsusetz, XVI, fol. 32 ; Honzodsufu, XVIII, fol. 11, recto.

Hab. Hōsoan, leg. H. KAWAKAMI, anno 1895 ; Shintek, Tamsui, leg. T. MAKINO, anno 1896 ; in montibus Morrison 5000 ped. alt., leg. R. TORII, 1899 ; Sho-to-kaku, Shitemkoó, leg. K. MIYAKE, anno 1899.

DISTRIB. India borealis, et Japonia.

**2. *G. luteo-album* LINN.** Sp. Pl. ed-2, p. 1196 ; LESS. Synop. Comp. p. 331 ; DC. Prodr. VI, p. 230 ; HOOKER, Fl. Niger. p. 143 ; MIQ. Fl. Ind. Bat. II. p. 91 ; BENTH. Fl. Austral. III. 653 ; SONDER, Fl. Capens. III, p. 262 ; HOOKER, Handb. New Zeal. Fl, p. 154 ; CLARKE, Comp. Ind. p. 114 ; HEMSL. Biol. Centr.-Americ. II, p. 136 ; Hook. f. Fl. Brit. Ind. III, p. 288 ; HILLEBRAND, Fl. Hawai. p. 120 ; HENRY, List Pl. Formos. p. 53.

Hab. Shoku, Shinteku, leg. K. MIYAKE, anno 1899.

DISTRIB. In calidis et temperatis regionibus late diffusa.

**3. *G. japonicum* THUNB.** Jap. p. 311 ; BENTH. Fl. Austral. III. p. 653 ; SIEB. et ZUCC. Fl. Jap. Fam. Nat. p. 187 ; DC. Prodr. VI, p. 237 ; FR. et SAV. Enum. Pl. Jap. I, p. 241 ; HANCE in Journ. Bot, 1880, p. 262 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 427 ; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 613.

*Guaphalium involucratum* FORST. DC. Prodr. VI, p. 235 ; Bot. Mag. t. 2582.

Ic. Jap. Sōmokudsusetz, XVI, fol. 33.



Hab. Taipea,, leg. T. MAKINO, anno 1896.

DISTRIB. Japonia, Australia et Nova-Zealandia.

**1. *G. indicum***, LINN. Sp. Pl. ed-2, p. 1200 ; LOUR. Fl. Cochinch. ed-2, p. 608 ; DC. Prodr. VI, p. 231 ; MIQ. Fl. Ind. Bat. II, p. 92 ; BENTH. Fl. Hong. p. 188 ; et Fl. Austral. III, p. 655 ; CLARKE, Comp. Ind. p. 114 ; OLIVER, Fl. Tropic. Afric. III, p. 345 ; HOOK. f. Fl. Brit. Ind. III, p. 289 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 427 ; HENRY, List Pl. Formos. p. 53.

Hab. Taiko-kûe, leg. Y. TASHIRO, anno 1897 ; Shu-shu-kôe, Rinpoho, leg. C. OWATARI, anno 1898.

DISTRIB. Tropica Asia, Africa et Australia.

## 32. *Carpesium* LINN.

**1. *C. abrotanoides*** LINN. Sp. Pl. ed-2, p. 1204 ; THUNB. Fl. Jap. p. 312 ; DC. Prodr. VI, p. 282 ; CLAREE, Comp. Ind. p. 131 ; HOOK. f. Fl. Brit. Ind. III, p. 301 ; MAXIM. in Mém. Biol. IX, p. 290 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 430 ; HENRY, List Pl. Formos. p. 54 ; DIELS, Fl. Centr. Chin. Eng. Jahrb. XXIX, p. 615.

Ic. Jap. Somokudsusetz vol. 15, fol. 62, sub. Hondzo-dsufu vol. 16, fol. 5. verso.

Hab. in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899.

DISTRIB. Europea orientalis, India borealis et Japonia.

## 33. *Echinops* LINN.

**1. *E. dahuricus*** Fisch.; DC. Prodr. VI, p. 523 ; FRANCH. Pl. David. p. 176 ; HENRY, List Pl. Formos. p. 55.

*Echinops Gmelinii* LEDEB. Fl. Ross. II, p. 653; MAXIM. Prim. Fl. Amur. p. 167.

*Echinops Sphaerocephalus* MIQ. in Ann. Mus. Bot. Lugd-Bat. II, p. 182; FR. et SAV. Enum. Pl. Jap. I, p. 253.

HAB. Shintek, leg. T. MAKINO, anno 1896; Chūko, leg. Y. HONDA, anno 1899.

DISTRIB. Siberia et Japonia.

### 34. *Cnicus* LINN.

#### *Conspectus Specierum.*

Caulis 2-3-pedes longus, involucri bractee angustiores....1. *C. japonicus*.

Caulis pede humilior, involucri bractee exteriores latiores.  
(ovato-lanceolatae.) .....2. *C. brevicaulis*.

**1. *C. japonicus*** MAXIM. in Mém. Biol. IX, p. 322; FR. et SAV. Enum. Pl. Jap. I, p. 260; FORB. et HEMSL. Ind. Fl. Sin. I, p. 461; HENRY, List Pl. Formos. p. 55;

*Cirsium japonicum* DC. Prodr. VI, p. 640; HOOK. et ARN. Bot. Beech. Voy. p. 266.

*Carduus japonicus* FRANCH. Pl. David. p. 178.

*Cirsium Maackii* MAXIM. Prim. Fl. Amur. p. 172.

HAB. Naigi, leg. C. OWATARI, anno 1898; in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899.

DISTRIB. Japonia.

**2. *C. brevicaulis*** A. GRAY; MAXIM. in Mém. Biol. IX, p. 324; HENRY, List Pl. Formos. p. 55.

*Cirsium brevicaulis* A. GRAY, Bot. Jap. p. 396.

Hab. loco non indicato.

DISTRIB. Japonia.

### 35. *Saussurea* DC.

**1. *S. affinis*** SPRENG. ; CLARKE, Comp. Ind. p. 232 ; HOOK. f. Fl. Brit. Ind. III, p. 373 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 463 ; HENRY, List Pl. Formos. p. 55 ; DIELS, Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 624.

*Saussurea carthamoides* BENTH. Fl. Hongk. p. 168, et Fl. Austral. III, p. 456.

*Aplotaxis carthamoides* DC. Prodr. VI, p. 540.

*Serratula carthamoides* BUCH. ex ROXB. Fl. Ind. III, p. 407.

*Aplotaxis multicaulis* DC. Prodr. VI, p. 540 ; MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 183.

*Aplotaxis Bungei*, DC. Prodr. VI, p. 539.

*Hemistepta lyrata* BUNGE ; MAXIM. in Mil. Biol. IX, p. 334.

*Saussurea Bungei* BENTH. et HOOK. f. ex. Fr. et Sav. Enum. Pl. Jap. I, p. 255 ; FRANCH. Pl. David. p. 182.

Hab. Anping, leg. H. KAWAKAMI, anno 1896 ; Bo-riyo, leg. C. OWATARI, anno 1898 ; Daito: Suibi, leg. K. MIYAKE, anno 1899 ; Daichu : Daiboho-shō, leg. R. SATAKE, anno 1899 ; in montibus Morrison 5000 ped. alt., leg. R. TORII, anno 1899.

DISTRIB. In India or., Birma, Japonia et Australia.

## 36. *Crepis* L.

### *Conspectus Specierum.*

*Folia lyrata* v. *subintegra*, *tenuia* .....1. *C. japonica*.

*Folia integerrima*, *crassiuscula* .....2. *C. integra*.

**1. *C. japonica*** BENTH. Fl. Hongk. p. 194; et Fl. Austral. III, p. 670; MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 190; MAXIM. in Mél. Biol. IX, p. 346; FR. et SAV. Enum. Pl. Jap. I, p. 271; FRANCH. Pl. David. p. 185; HOOK. f. Fl. Brit. Ind. III, p. 395; HEMSL. in Voy. Chall. I, part 1, p. 46; HILLEBRAND, Fl. Hawai. p. 233; FORB. et HEMSL. Ind. Fl. Sin. I, p. 475; HENRY, List Pl. Formos. p. 55; DIELS, Fl. Centr.-Chin. in Engl. Jahrb. XXIX, p. 632.

*Prenanthes japonica* LINN. ; THUNB. Fl. Jap. p. 302; HOOK. et ARN. Bot. Beech. Voy. p. 266.

*Youngia japonica* DC. Prodr. VII, p. 194.

*Crepis lyrata* BENTH. ex MAXIM, in Mél. Biol. IX, p. 346.

*Youngia Thunbergiana* DC. Prodr. VII, p. 192.

*Prenanthes lyrata* THUNB. Fl. Jap. p. 303.

*Youngia rucinata*, *Y. napifolia*, *Y. Poosia*, *Y. ambigua*, *Y. fastigiata* et *Y. striata* DC. Prodr. VII, pp. 192–193; ex HOOK. f. Fl. Brit. Ind. III, p. 395.

Icon. Jap. Somokudsusetz vol. 15, fol. 30.

Hab. Taipea, leg. T. MAKINO, anno 1896; et C. OWATARI, anno 1897; Taichu-ken: Toseikaku, leg. R. SATAKE, anno 1899.

DISTRIB. India, Japonia, et Australia.

**2. *C. integra*** MIQ. in ANN. Mus. Bot. Lugd.—Bat. II, P. 190; MAXIM. in Mém. Biol. IX, p. 348. FORB. et HEMSL. Ind. Fl. Sin. I, p. 475.

*Prenanthes integra* THUNB. Fl. Jap. p. 300; HOOK. et ARN. Bot. Beech. Voy. p. 266.

*Youngia lanceolata*. DC. Prodr. VII, p. 193.

*Prenanthes lanceolata* HOUTT.; WILLD. Sp. Pl. III, p. 1534.

*Youngia integra* A. GRAY, Bot. Jap. in Mem. Amer. Acad. VI, p. 396.

Icon. Jap. Somokudsusetz vol. 15, fol. 26.

Hab. Gishun, leg. K. MIYAKE, anno 1899.

Distrib. Japonia.

## 37. *Taraxacum* Hall.

**1. *T. officinale*** WEB.; LEDEB. Fl. Ross. II, p. 812; GRISEBACH, Fl. West Ind. Isl. p. 384; SOWERBY, English Bot. t. 1304; FR. et SAV. Enum. Pl. Jap. I, p. 269; CLARKE, Comp. Ind. p. 258; HEMSL. Biol. Cent.-Americ. II, p. 261, et IV, p. 65; HEMSL. Voy. Chall. I, part 1, p. 46; HOOK. f. Fl. Brit. Ind. III, p. 401; BAKER et S. MOOR. in Journ. Linn. Soc. XVII, p. 383; FORB. et HEMSL. Ind. Fl. Sin. I, p. 478. A. GRAY, Synop. Fl. N. Americ. ed. 2, I, part 2, p. 440; HENRY, List Pl. Formos. p. 55; DIELS, Fl. Centr. China, in Engl. Jahrb. XXIX, p. 630.

*Taraxacum Deus-leonis* DISF.; DC. Prodr. VII, p. 145; BENTH. Fl. Hongk. p. 192.

*Taraxacum corniculatum* DC. Prodr. VII, P. 146; FRANCH. Pl. David. p. 187.

Icon. Jap. Somokudsusetz vol. 15, fol. 10.

Hab. Shintek, leg. T. MAKINO, anno 1896.

DISTRIB. In regionibus temperatis frigidisque fere orbis late diffusa.

### 38. *Lactuca* LINN.

#### *Conspectus Specierum.*

- Involucrum angustum, bracteis 3-seriatis valde inaequalibus imbricatis .....1. *L. brevirostris*.
- Involucrum latiusculum, bracteis 1-seriatis, aequalibus, additis exterioribus minimis adpressis.
  - Capitula multa, parva, 6-8 mm. longa.
    - △ Caulis validiusculus, 1-2-pedes longus.
      - ! Pappus rufo-albus .....2. *L. Thunbergiana*.
      - !! Pappus omnino albus .....3. *L. versicolor*.
    - △△ Caulis gracilis, 10-15 cm. longus .....4. *L. gracilis*.
  - Capitula pauca, majuscula, 12-mm. longa.
    - △ Folia oblonga v. lanceolata, integra v. leviter pinnatifida .....5. *L. debilis*.
    - △△ Folia ovata, 3-lobata, v. 3-secta .....6. *L. repens*.

1. *L. brevirostris* CHAMP. ; BENTH. Fl. Hongk. p. 192 ; CLARKE, Comp. Ind. p. 265 ; Hook. f. Fl. Brit. Ind. III, p. 405 ; Forb. et HEMSL. Ind. Fl. Sin. I, p. 479 ; HENRY, List Pl. Formos. p. 55.

*Lactuca squarrosa* MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 189 ; MAXIM. in Mém. Biol. IX, p. 353 ; FRANCH. Pl. David. p. 187 ;

*Lactuca amurensis* REGL. ; MAXIM. Prim. Fl. Amur. pp. 178-473, fide HEMSL.

Icon. Jap. Somokudsusetz vol. 15, fol. 12.

Hab. Taipea, leg. T. MAKINO, anno 1896 ; Kotosho, leg. K.

MIYAKE, anno 1899 ; Senton, ipse, anno 1900.



DISTRIB. Mandshuria et Japonia.

**2. *L. Thunbergiana*** MAXIM. in Mém. Biol. IX, p. 361 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 484 ; K. MIYABE, Fl. Kurile Isl. in Mem. Bost. Soc. Nat. Hist. IV, p. 245.

*Ixeris Thunbergiana* A. GRAY, Bot. Jap. in Mem. Amer. Acad. VI, p. 397.

*Prenanthes dentata* THUNB. Fl. Jap. p. 301.

*Lactuca Oldhami* MAXIM. in Mém. Biol. IX, p. 363.

Icon. Jap. Somokudsusetz vol. 15, fol. 15.

Hab. Taipea, Shintek, Sha-ryo-to, leg. T. MAKINO, anno 1896 ; Cho-ka-chirai, Kachinrō, leg. C. OWATARI, anno 1898 ; Ku-chū, Shitemkue, Taito-tea, Dai-ko-sha, Kotosho, leg. K. MIYAKE, anno 1899 ; leg. T. SHINKE, anno 1899 ; Senton, ipse, anno 1900.

DISTRIB. in Japonia, et Philippinis insulis.

**3. *L. versicolor*** SCHULTZ-BIP. ; MAXIM. in Mém. Biol. IX, p. 362 ; BAKER et MOORE, in Journ. Linn. Soc. XVII, p. 383 ; FRANCH. Pl. David. p. 188 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 485 ; HENRY, List Pl. Formos. p. 56 ; DIELS, Fl. Centr.-Chin. in Engl. Jahrb. XXIX, p. 631.

*Ixeris versicolor* DC. Prodr. VII, p. 151 ; BENTH. Fl. Hongk. p. 193 ; MIQ. in Ann. Mus. Bot. Lugd.-Bat. II, p. 191 ; LEDEB. Fl. Ross. II, p. 817.

*Prenanthes chinensis* THUNB. Fl. Jap. p. 301.

*Youngia chinensis* DC. Prodr. VII, p. 194.

Icon. Jap. Somokudsusetz vol. 15, fol. 19.

Hab. Taipea, Tamsui, leg. T. MAKINO, anno 1896 ; Taïko, leg. C. OWATARI, anno 1897.

DISTRIB. Dahuria et Japonia.

**4. *L. gracilis*** DC. Prodr. VII, p. 140; CLARKE, Comp. Ind. p. 271; HOOK. f. Fl. Brit. Ind. III, p. 410; FORB. et HEMSL. Ind. Fl. Sin. I, p. 482; DIELS. Fl. Centr. Chin. in Engl. Jahrb. XXIX, p. 631.

Hab. Taitocho: Perung, leg. K. MIYAKE, anno 1899.

DISTRIB. in India or..

**5. *L. debilis*** MAXIM. in Mém. Biol. IX, p. 365; FORB. et HEMSL. Ind. Fl. Sin. I, p. 480; HENRY, List Pl. Formos. p. 56.

*Ixeris debilis* A. GRAY, Bot. Jap. in Mem. Amer. Acad. n. s. VI, p. 397; BENTH. Fl. Hongk. p. 193; MIQ. in Ann. Mus. Bot. Lugd-Bat, II, p. 191.

*Youngia debilis* DC. prodr. VII, p. 194.

*Prenanthes debilis* THUNB. Fl. Jap. p. 300.

Icon. Jap. Somokudsusetz vol. 15, fol. 16.

Hab. loco non indicato.

DISTRIB. Japonia.

**6. *L. repens*** MAXIM. in Mém. Biol. IX, p. 364; FORB. et HEMSL. Ind. Fl. Sin. I, p. 483; K. MIYABE, Fl. Kurile Isl. in Mem. Bot. Soc. Nat. Hist. vol. IV, p. 245; HENRY List Pl. Formos. p. 56.

*Ixeris repens* A. GRAY Bot. Jap. in Mem. Amer. Acad. n. s. VI, p. 397. BENTH. Fl. Hongk. p. 194.

Icon. Jap. Somokudsusetz vol. 15, fol. 18; Hondsodsufu vol. 49, fol. 22, recto.

Hab. Tamsui, leg. T. MAKINO, anno 1896.

DISTRIB. Mandshuria, Japonia et Kamtschatka.

### 39. *Sonchus* LINN.

#### *Conspectus Specierum.*

- |   |                          |
|---|--------------------------|
| Folia grosse dentata v. pinnatifida ..... | 1. <i>S. oleraceus</i> . |
| Folia remote serrata .....                | 2. <i>S. arvensis</i> .  |

**1. *S. oleraceus*** LINN. Sp. Pl. ed-2, p. 1116 ; ROXB. Fl. Ind. III, p. 402 ; LESS. Synop. Comp. p. 140 ; HOOKER. Fl. Niger. p. 144 ; MIQ. Fl. Ind. Bat. II, p. 112 ; BENTH. Fl. Hongk. p. 194 ; SONDER, Fl. Capens. III, p. 528 ; HOOK. Fl. N. Zeal. p. 166 ; BENTH. Fl. Austral, III, p. 679 ; GRISEBACH, Fl. Brit. West. India. Isl. p. 384 ; FR. et SAV. ENUM. Pl. Jap. I, p. 272 ; CLARKE, Comp. Ind. p. 276 ; OLIVER, Fl. Tropic. Afric. III, p. 457 ; HOOK. f. Fl. Brit. Ind. III, p. 414. HEMSL. Voy. Chall. I, part 1, p. 46 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 487 ; A. GRAY. Synop. Fl. N. Americ. ed-2, I, part 2, p. 444 ; Hillebrand, Fl. Hawai. p. 233 ; HENRY, List Pl. Formos. p. 56.

*S. ciliatus* LAM. DC. Prodr. VII, p. 185.

Icon. Jap. Somokudsusetz vol. 15, fol. 6. Hondsodsufu vol. 49, fol. 3, recto.

Hab. Taipea, leg. T. MAKINO, anno 1896 ; Gishun, leg. Y. TASHIRO, anno 1898.

DISTRIB. In temperatis et subtropicis regionibus late diffusa.

**2. *S. arvensis*** LINN. Sp. Pl. ed-2, p. 1116 ; DC. Prodr. VII, p. 187 ; SOWERBY, English Bot. t. 1308 ; FR. et SAV. Enum. Pl. Jap. I, p. 273 ; CLARKE, Comp. Ind. p. 276 ; HOOK. f. Fl. Brit. Ind. III, p. 414 ; A. GRAY. Synop. Fl. N. America ed-2, I, part-2, p. 444 ; FORB. et HEMSL. Ind. Fl. Sin. I, p. 487 ; HENRY, List Pl. Formos. p. 56 ; DIELS, Fl. Centr.-Chin. in Engl. Jahrb. XXIX, p. 631.

*S. uliglonocus* BIEBERST ; DC. Prodr. VII, p. 186 ; MAXIM. Ind. Fl. Pek. in Prim. Fl. Amur. p. 473. FRANCH. Pl. David. p. 189, fide HEMSL.

*S. brachyotus* DC. Prodr. VII, p. 186.

Jap. Icon. Somokudsusetz vol. 15, fol. 7.

Hab. Taipea, leg. T. MAKINO, anno 1896 ; Koto-sho, leg.  
K. MIYAKE, anno 1899.

DISTRIE. In temperatis et subtropicis regionibus late  
diffusa.



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B. HAYATA.  
Compositæ Formosanæ.

PLATE I.

*Eupatorium Tashiroi* HAYATA.

## EXPLICATIO TABULAE.

*Eupatorium Toshioi*, HAYATA.

Planta tabulae ex specimine exsiccato depicta.

- Fig. 1. Fragmentum rami. mag. nat.
  - Fig. 2. Capitulum. mag. auct.
  - Fig. 3. Flos. mag. auct.
  - Fig. 4. Achaenium, cum pappo superne amorto, validissime auctum.
  - Fig. 5. Ejus verticalis sectio, validissime aucta.
  - Fig. 6. Achaenii horizontalis sectio, validissime aucta.
-



*Eupatorium tachinoides* Hayata





B. HAYATA.  
Compositæ Formosanæ.

PLATE II.

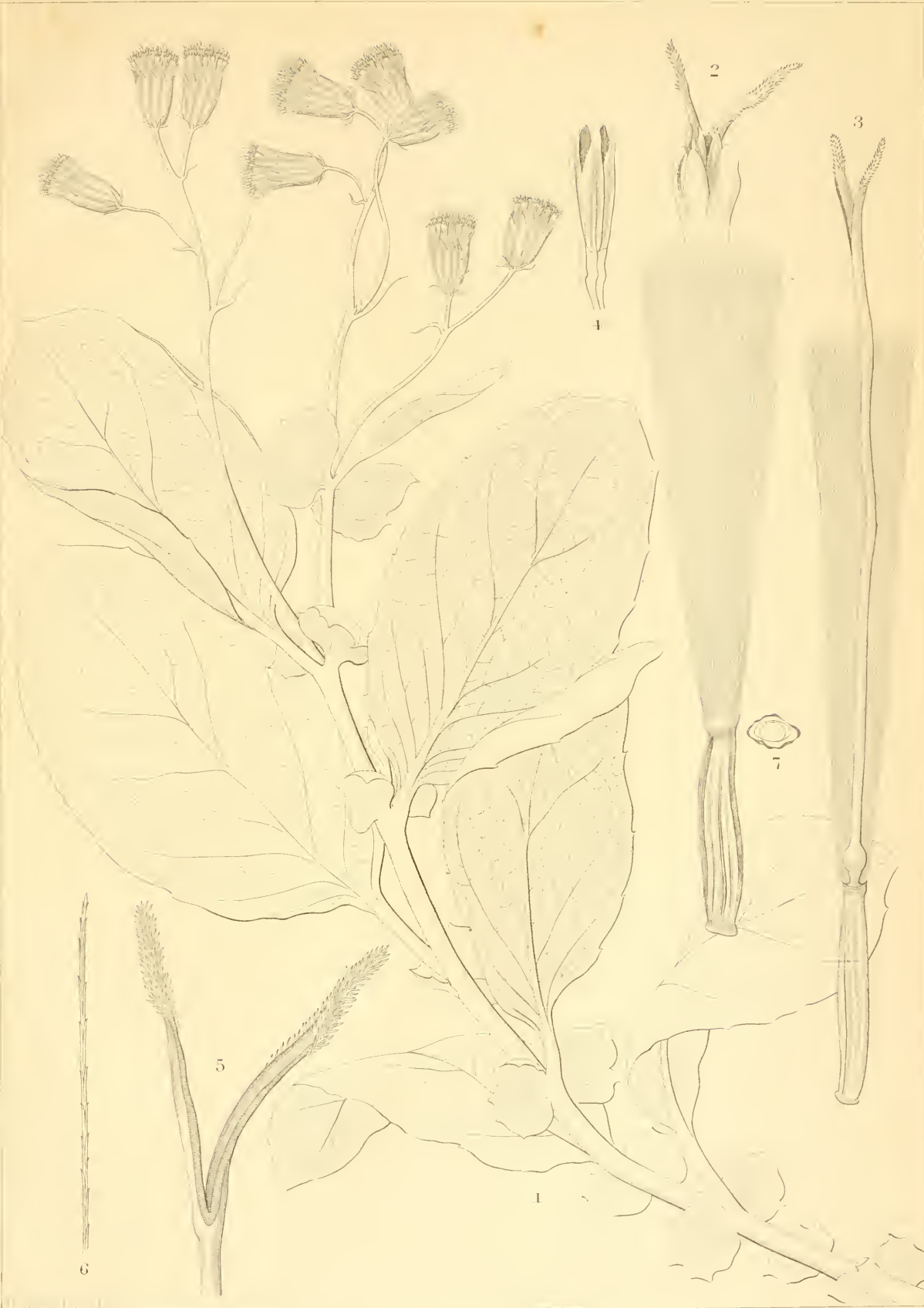
*Gynura elliptica* YABE et HAYATA.

## EXPLICATIO TABULAE.

*Gynura elliptica*, YABE et HAYATA.

Planta tabulae ex specimine exsiccato depicta.

- Fig. 1. Pars plantae. mag. nat.
  - Fig. 2. Flos. mag. auct.
  - Fig. 3. Flos, corolla et stamina amorta, stylus videtur. mag. auct.
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  - Fig. 5. Styli rami, validissime aucti.
  - Fig. 6. Pappi seta, validissime aucta.
  - Fig. 7. Achaenii horizontalis sectio. mag. auct.
-



*Gymura latifolia* Hayata

















